1993 Annual Report of the Adaptive COASTAL OREGON PRODUCTIVITY ENHANCEMENT Program

October 1, 1992 - September 30, 1993

Adaptive COPE Program
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THE COASTAL OREGON PRODUCTIVITY ENHANCEMENT (COPE) PROGRAM

Initiated in 1987, the Coastal Oregon Productivity Enhancement (COPE) Program is a cooperative effort between the College of Forestry at Oregon State University (OSU), the USDA Forest Service Pacific Northwest Research Station (PNW), the USDI Bureau of Land Management (BLM), other federal and state agencies, forest industry, county governments, and the Oregon Small Woodlands Association. The intent of the program is to provide resource managers and the public with information on management of fish, timber, water, wildlife, and other resources of the Oregon Coast Range. To find effective ways to manage these diverse resources collectively, the COPE Program integrates research, education, and scientific disciplines.

The COPE Program has two related components; scientists in both Fundamental COPE and Adaptive COPE focus on problems related to riparian-zone management and the regeneration of Oregon Coast Range forests. Fundamental COPE scientists, mainly from OSU and PNW in Corvallis, conduct basic research studies. Basic research under Fundamental COPE is supported by the USDA Forest Service and USDI Bureau of Land Management. Adaptive COPE, an interdisciplinary team of OSU College of Forestry scientists, applies and adapts existing research to Oregon Coast Range conditions. Stationed in Newport at the Hatfield Marine Science Center, the Adaptive COPE team also facilitates information transfer by providing continuing education opportunities. Adaptive COPE scientists work with county Forestry Extension agents to extend the program throughout the 13-county area of the Oregon Coast Range. The Adaptive COPE Program is funded by over 34 different organizations, including federal and state agencies, forest industries, county and city governments, and the Oregon Small Woodlands Association.

COPE ORGANIZATION

Advisory Council
Representatives of COPE Cooperators
Provides advice and guidance on program direction
(listing on inside back cover)

Dean, College of Forestry
George Brown
Convenes Advisory Council
Makes major decisions on OSU support

Director, PNW Station
Charles Philpot
Makes major decisions on PNW support

COPE Program Manager
Stephen Hobbs

Coordinates activities of all organizations involved and provides overall program leadership and administration

Adaptive COPE
OSU College of Forestry scientists

Conducts adaptive research and facilitates transfer of information

Fundamental COPE
OSU and PNW scientists

Conducts basic research

Adaptive COPE Staff

Scientists:
Forest Engineering
Soil Science/Hydrology: Arne Skaugset

Forest Science
Wildlife: John P. Hayes
Silviculture: Gabriel F. Tucker
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Research Support
Doug Bateman
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COOPERATORS

Federal Agencies

Bureau of Indian Affairs
Bureau of Land Management
Pacific Northwest Research Station
Siskiyou National Forest
Siuslaw National Forest
U.S. Fish and Wildlife Service

State Agencies

Department of Fish and Wildlife
Department of Forestry
Oregon State University

Oregon Counties

Benton
Coos
Curry
Douglas
Josephine
Lincoln
Polk
Washington

Forest Industries

Boise Cascade Corporation
Georgia-Pacific Corporation
Giustina Land & Timber Company
Hydraulic & Machine Services, Incorporated
Longview Fibre Company
Menasha Corporation
Papé Brothers, Incorporated
Rosboro Lumber Company
Roseburg Resources Company
RSG Forest Products, Incorporated
Smurfit Newsprint Corporation
Starker Forests, Incorporated
Stimson Lumber Company
Weyerhaeuser Company
Willamette Industries, Incorporated
Willamina Lumber Company

Other

City of Newport
Oregon Small Woodlands Association

CONTENTS

HIGHLIGHTS FOR FISCAL YEAR 1993

During its sixth year of research and education activities, Adaptive COPE:

- Initiated three new studies of wildlife in managed Coast Range forests: 1) habitat relationships of arboreal rodents, 2) influence of silvicultural operations on wildlife populations, and 3) habitat relationships of bats.
- Made major progress in implementing a large, integrated study on the response of many forest resources to active management in riparian zones.
- Initiated a major integrated study on commercial thinning to enhance stand structure and diversity.
- Completed a study and prepared a manuscript on computer modeling of forest and wildlife habitat dynamics in managed forests.
- Continued eight studies in Adaptive COPE's study areas of slope stability, wildlife and fisheries, riparian silviculture, stream-borne woody debris, and reforestation.
- Completed a collection of published and unpublished data on large woody debris in the Oregon Coast Range.
- Published six articles.
- Conducted a tour of COPE research sites on the Siuslaw National Forest for staff members of Oregon's congressional delegation and the Governor's Office.
- Co-sponsored a major workshop on forest soils and riparian-zone management. The workshop was given to honor Henry A. Froehlich, professor emeritus of forest engineering at the OSU College of Forestry, for his long and fruitful career.
- Sponsored a day-long workshop on commercial thinning and underplanting to enhance the diversity of forests and streams. The workshop was repeated twice because of public demand.
- Gave many formal and informal presentations in a wide variety of forums, including professional meetings, college science classrooms, and a radio interview.
- Presented papers and posters at several scientific gatherings.
- Published four issues of the *COPE Report* quarterly newsletter. The newsletter highlights Fundamental and Adaptive COPE research and technology transfer activities. Newsletters were distributed to over 2,100 readers.
- Continued to exchange information about the COPE Program with cooperators and citizens through field tours, office visits, and consultation.

INTRODUCTION

The COPE Program was initiated in 1986 with the objective of increasing knowledge of the fisheries, wildlife, timber resources, water, and soils of the Oregon Coast Range in order to help managers maintain and enhance the productivity of the diversity of forest resources there. The role of Adaptive COPE is to develop and adapt research information to address specific multiple-resource and management questions.

When the COPE program began, the pertinent resource issues included the withdrawal of federal lands from the timber base, the decline of fish runs, and increasing public concern for nongame wildlife. Since that time, additional developments, such as the listing of the northern spotted owl and the marbled murrelet, the potential listing of several Coast Range fish stocks, and the growing attention being paid to questions of biological diversity, all have intensified the need for better information about all these resources.

Several Adaptive COPE studies initiated early on are already providing valuable information upon which resource managers can base sound decisions. Two far-reaching new studies were initiated this year, and a third is on the drawing board. These and all other ongoing studies are scheduled for completion by our "sunset" year of 1998.

Adaptive COPE's commitment to outreach is directed at getting research results quickly into the hands of on-the-ground managers. This year, Adaptive COPE sponsored or co-sponsored six major workshops or symposia that reached over 1,500 participants. We produced four issues of the COPE Report and initiated many formal and informal visits with interested people.

Some new faces were added to Adaptive COPE during the year. Dr. Bill Emmingham, associate professor and Extension silviculture specialist in the Department of Forest Science at OSU, has joined the team. He will assume Gabe Tucker's silviculture studies in January of 1994, when Tucker leaves the university to pursue other interests. Emmingham has many years of research experience in the Oregon Coast Range. He will be working closely with another new member of the team, Kathleen Maas. Maas, who has a master's degree in forest ecology, joined Adaptive COPE last winter as a research assistant.

Elizabeth Dent joined Adaptive COPE in July, also as a research assistant. Dent has a master's degree in forest engineering from OSU, with a focus on hydrology. The Adaptive team is continuing its search for an additional master's-level research assistant with expertise in wildlife ecology.

SLOPE STABILITY

MODELING ROOT REINFORCEMENT IN SHALLOW FOREST SOILS

(Arne Skaugset—Adaptive COPE; Marvin Pyles—OSU Department of Forest Engineering)

Landslides are common in the Oregon Coast Range because of the combination of steep slopes, shallow soils, and prolonged and sometimes intense winter rainfall. Historically, road-related landslides have been the dominant source of management-caused erosion. As road construction and maintenance practices have improved, however, road-related landslides have diminished in importance, and the emphasis has shifted to landslides elsewhere in harvest units.

In-unit landslides result, in theory, when the roots of harvested trees decay, reducing soil reinforcement and thus soil strength. The goal of this research is to develop a model to predict the increase in soil strength attributable to root reinforcement. The objectives of this project are 1) to develop a process-based, mechanistic model of root reinforcement in shallow forest soils, and 2) to carry out a parameter study with the model and compare its results with data available in the literature.

The conceptual development of the analytical model was reported in *COPE Report* 2(2):4-7. The concept for the model is based on reinforced-earth theory. The roots are treated as reinforcing elements in the soil and modeled mathematically as axially and laterally loaded piles. The solutions to the differential equations governing the behavior of the reinforcing roots, are approximated using the finite difference method. The analytical model is currently being programmed. Once it is completed, a sensitivity analysis will be carried out to determine how the model will perform over a range of soil and root properties. The model results will subsequently be compared with values in the technical literature.

This project should help increase our understanding of how roots reinforce shallow forest soils, and therefore should be of value in managing landslide-prone terrain. The model should also be valuable for those interested in investigating the effect of vegetation type and density on the stability of high-risk sites and assessing the effects of alternative silvicultural practices on soil strength. Present slope-stability models that require information on root reinforcement could be improved by incorporating information from this model.

ASSESSING THE STABILITY OF END-HAUL DISPOSAL AREAS

(Arne Skaugset—Adaptive COPE; Marvin Pyles and Clint Davis—OSU Department of Forest Engineering; Dave Michael, Keith Mills, and John Seward—Oregon Department of Forestry; Jerry Richeson—Bureau of Land Management; Bob Young—Siuslaw National Forest)

End-hauling is the practice of loading and hauling road construction spoil from steep terrain to more stable locations. Locating sufficiently flat and stable end-haul disposal sites is a significant problem in the steep, highly dissected terrain of the Coast Range. Recent experience has shown that relatively flat, apparently stable terrain may fail when spoil material is placed on it. The failure rate for end-haul disposal areas is small, but the consequences of failure can be significant. Because this problem has never been rigorously investigated, there are no formal criteria for selecting end-haul disposal sites. The primary objective of this project is to formulate a set of recommendations for identifying stable end-haul disposal sites.

Our initial research has produced a preliminary inventory of end-haul sites and their approximate volumes (Figure 1). Most of these end-haul sites are located in the southern Coast Range. Some of them exhibit signs of instability.

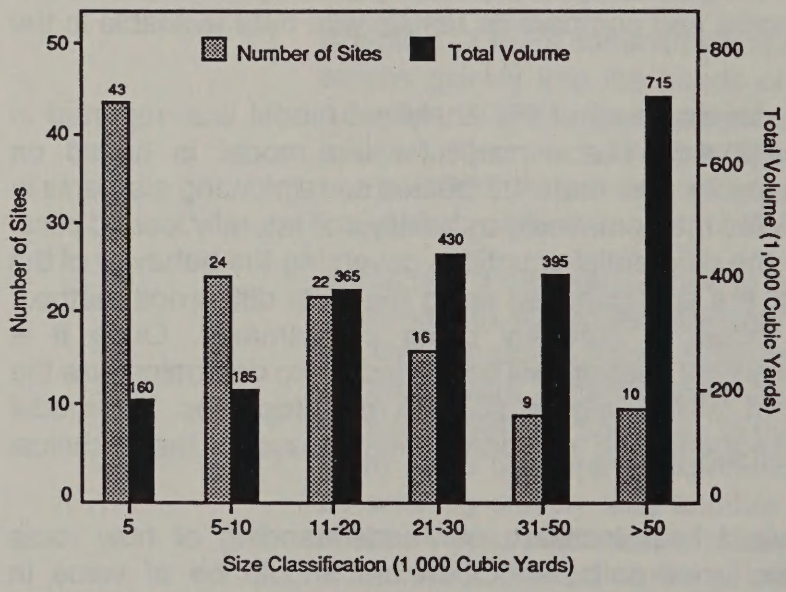


Figure 1. Preliminary inventory of end-haul disposal sites. Numbers of sites and earth volumes are shown for various size classifications.

From this inventory, certain sites, including all the failed sites, will be chosen for investigation. The sites will be surveyed, the site geology modeled, and strength-limiting soil parameters determined. Data from investigations of failed sites will be used to develop strength parameters to predict the stability of unfailed sites. As part of this work, we will analyze certain soil parameters that limit the stability of slopes where end-haul material has been placed. Also, since personnel who must evaluate sites for end-haul disposal often have limited subsurface data

to work with, we will also identify relationships between levels of detail of geologic data and accuracy of the stability analyses resulting from such data. The investigation and analysis are scheduled to be completed in 1994.

WILDLIFE AND FISHERIES

LONG-TERM RESPONSE OF RESIDENT CUTTHROAT TROUT TO FOREST HARVEST

(Patrick J. Connolly and James D. Hall—OSU Department of Fisheries and Wildlife; Arne Skaugset—Adaptive COPE)

The primary objective of this study is to characterize the response of resident cutthroat trout in Oregon's Coast Range streams to logging conducted before the adoption of the state Forest Practices Act in 1972.

Cutthroat trout are often the only fish species occupying first- and second-order Coast Range streams. Most second-growth forests that will be ready for harvest in the next 30 years were harvested before the state forest practice rules were in place. Because the degree of stream protection required in today's management operations depends on whether fish inhabit a stream (and, until recently, on fish density and size as well), it will be useful to know how cutthroat trout populations responded to the first logging event (which did not allow for buffer-strip leave areas) in order to assess a basin's potential for maintaining these populations.

Thirteen first- and second-order streams have been sampled to date. All are westside drainages of the mid-coastal region of Oregon, ranging from the tributaries of the Siletz drainage in the north to the Big Creek basin (Lincoln County) in the south. The watersheds range in size from 0.5 to 3.5 km^2. Four of the basins have not been logged, five were logged 20-30 years ago, and four were logged 40-60 years ago.

Preliminary results suggest that the density of cutthroat trout 1 year old or older varies with the timing of past harvest operations (Figure 2). Unlogged basins supported relatively low densities of cutthroat trout and had the lowest variability in density. Basins logged 20-30 years ago supported the lowest and highest densities encountered in the study and had the highest variability in density among streams. Basins logged 40-60 years ago had low to intermediate densities and expressed an intermediate level of variability among streams.

Factors that may interact with the response of cutthroat trout to logging, such as stream gradient, substrate, and large woody debris, are being investigated. A final field season, to be completed by the end of this summer (1993), will increase the number of streams studied.

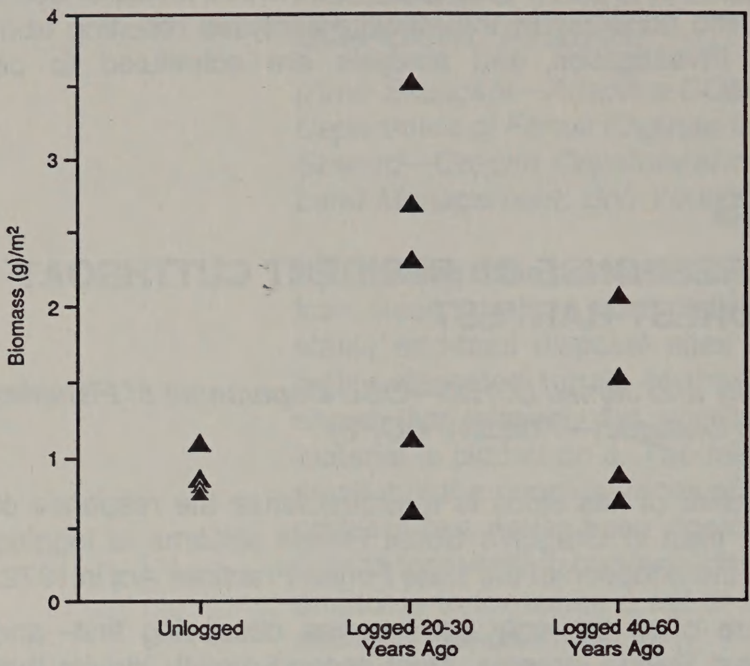


Figure 2. Density of cutthroat trout aged ≥1 year in 13 streams, divided into three classes based on past forest management and age of the forest stand within the basins.

HABITAT RELATIONSHIPS OF ARBOREAL RODENTS IN MANAGED COAST RANGE FORESTS

(John P. Hayes, Gabriel F. Tucker, and Eric Horvath—Adaptive COPE)

Arboreal rodents are important elements of regional biodiversity. They play a critical role in energy flow in Oregon Coast Range forests and are important in dispersal of the spores of mycorrhizal fungi. In addition, arboreal rodents are the primary prey species of many predators, including the northern spotted owl.

Previous research indicates that arboreal rodents may be particularly sensitive to changes in forest structure, but their response to forest management has not been fully explored. Although some studies suggest that arboreal rodents are closely associated with late-seral-stage forests, little empirical research is available on this question, and almost no data are available from Oregon Coast Range forests. The lack of information is particularly acute for questions concerning use of young forest stands by flying squirrels and questions concerning our ability to create suitable habitat for arboreal rodents silviculturally—through commercial thinning, for example. In addition, information on habitat relationships of another species of arboreal rodent, the red tree vole, is very poor, and much of it is scattered in obscure sources.

A better understanding of the habitat relationships of arboreal rodents will help forest resource managers make better decisions. In this study we hope to improve understanding of how various silvicultural and management activities influence arboreal rodent populations in managed forests in the Oregon Coast Range.

The study has three primary objectives: 1) to determine the relationship between forest structure and habitat utilization by arboreal rodents, with an emphasis on habitat utilization of young forests by flying squirrels; 2) to synthesize existing information concerning patterns of habitat utilization, natural history, and biology of the red tree vole; and 3) to determine the value and feasibility of additional field research on arboreal rodents in young and managed forests in the Oregon Coast Range.

For the field component of the project, three stands in each of four age classes were chosen for study: fire-regenerated stands of over 120 years old and Douglas-fir plantations of 10-15 years old, 20-25 years old, and 30-35 years old. Stands were trapped with Tomahawk live traps, and all chipmunks and flying squirrels captured were marked and released.

Two 6-week trapping sessions have been completed (fall 1992 and spring 1993). Preliminary results from the fall session were presented in *COPE Report* 6(2)4-6. Substantial population data were collected for chipmunks and flying squirrels. Estimates of chipmunk densities based on these data did not differ significantly within stands between seasons, but they varied dramatically between stands in both fall and spring. The between-stand variation was not closely associated with stand age (Table 1). Chipmunk numbers may correspond more closely to vegetative, rather than structural, characteristics of a stand. We are currently analyzing vegetative data for the stands.

Table 1. Estimated number of Townsend's chipmunks per hectare in each of the trapping areas.

Stand age	Risley		Lyndon		Peterson	
	Fall	Spring	Fall	Spring	Fall	Spring
10-15	22.9	20.4	5.3	7.3	11.6	13.7
20-25	0.0	0.0	6.7	4.9	9.2	10.0
30-35	10.1	11.4	5.3	7.1	17.4	15.1
mature	5.7	3.8	10.0	7.8	23.8	17.5

Capture success of flying squirrels was highly variable (Table 2). Overall capture success was extremely low in the youngest forest stands examined, suggesting that forest stands of this age provide poor habitat for flying squirrels. Among other age classes, capture success varied considerably. Although greater numbers of flying squirrels were typically captured in mature stands than in plantations, we had high capture success in some of the younger stands (for example, the Peterson plantation, 20 - 25 years old). These results suggest that habitat characteristics necessary to support large populations of flying squirrels are generally present in older forest stands, but are occasionally present in young stands as well.

Stand age	Risley	Lyndon	Peterson
10-15	0.1	0.0	0.1
20-25	0.5	0.2	1.7
30-35	0.3	1.0	0.9
mature	1.2	1.2	2.0

Table 2. Number of flying squirrels captured per 100 trap nights (both trapping sessions combined).

A more complete understanding of the reasons underlying the pattern of abundance observed in this study awaits analysis of habitat characteristics. The presence of large trees in young stands may substantially improve the habitat suitability of these stands for flying squirrels.

INFLUENCE OF SILVICULTURAL OPERATIONS ON STAND STRUCTURE AND WILDLIFE ABUNDANCE AND DIVERSITY IN MANAGED COAST RANGE FORESTS

(John P. Hayes and William H. Emmingham—Adaptive COPE; William C. McComb and Stephen D. Hobbs—OSU Department of Forest Science; Clint Smith—Oregon Department of Forestry; Loren Kellogg—OSU Department of Forest Engineering)

Considerable acreage in the Oregon Coast Range, on both public and private lands, is in an early-seral stage of development as a result of a history of fire and logging. Recently, there has been increased interest in enhancing wildlife values while maintaining acceptable levels of wood-fiber production.

Commercial thinning has been proposed as a means to meet both these resource needs in Coast Range forests. Silvicultural prescriptions are well established for commercial thinning focused on maximization of wood-fiber production; these are based on theoretical and applied studies and substantial practical experience in relating wood-fiber production to growing stock. However, considerably less information exists about how to use silvicultural prescriptions to incorporate wildlife goals into these young stands. Although some preliminary work has addressed this topic, fundamental questions about the response of wildlife populations to thinning activities and snag creation remain unanswered. As a result, the implications of various management strategies with respect to the welfare of wildlife are still unclear.

This study will examine the influence of snag density and commercial-thinning intensity on wildlife populations in managed plantations in the Oregon Coast Range. The study has three primary objectives: 1) to determine the influence of different densities of created snags and different commercial thinning intensities on wildlife abundance and diversity; 2) to determine the influence of different spacing patterns of snags on utilization of snags by birds; and 3) to determine the influence

of forest gaps created by snags on stand development and natural regeneration. On completion, the project will identify many of the costs and benefits of using thinning operations to enhance wildlife populations.

This study is still in the planning stage. We are working closely with the staff at the Tillamook State Forest to identify appropriate study sites and to finalize the experimental design.

HABITAT RELATIONSHIPS AND RIPARIAN-ZONE ASSOCIATIONS OF BATS IN MANAGED COAST RANGE FORESTS

(John P. Hayes—Adaptive COPE; Stephen P. Cross—Department of Biology, Southern Oregon State College)

Studies of several species of vertebrates are beginning to clarify the relationships between wildlife and habitat structure, making it possible to evaluate the influence of management programs on wildlife populations. One important wildlife group that has been neglected in these studies, however, is bats. In this study we hope to provide the scientific basis to evaluate forest management alternatives that may influence bat populations in and adjacent to riparian areas.

Bats are extremely important to the region's biodiversity and ecology. Nearly 20 percent of the mammal species occurring in the Oregon Coast Range are bats. Of the 13 species of bats occurring in the Coast Range and Siskiyous, three are listed as sensitive species by the Oregon Department of Fish and Wildlife, and one of these is a candidate for federal threatened or endangered status. Bats are significant predators of nocturnal insects, some of which are forest pests, and bats are prey to other mammals and birds.

Only one study to date has examined bat communities in the Oregon Coast Range (Thomas 1988.) It showed that the abundance and diversity of bats are closely tied to stand age of forested upland areas. Upland habitat is used by many species of bats primarily as roosting habitat. Riparian zones are used by bats for both roosting and foraging. Although there is some evidence that bat populations may be influenced by habitat structure in riparian zones, no definitive studies have examined this relationship.

The goals of this study are to identify the importance of riparian zones to bat species in Coast Range forests and to determine the influence of landscape structure, forest structure, and stream and riparian characteristics on patterns of habitat utilization by bats. Initial research will rely primarily on monitoring echolocation calls of bats to determine their patterns of utilization of riparian areas. Species of bats use different frequencies of sound while echolocating during their foraging and orientation activity (Figure 3). We are recording their calls with equipment sensitive to high-frequency sound and will use this information to determine patterns of habitat utilization. This information will be supplemented by data collected by capturing bats with mist nets.

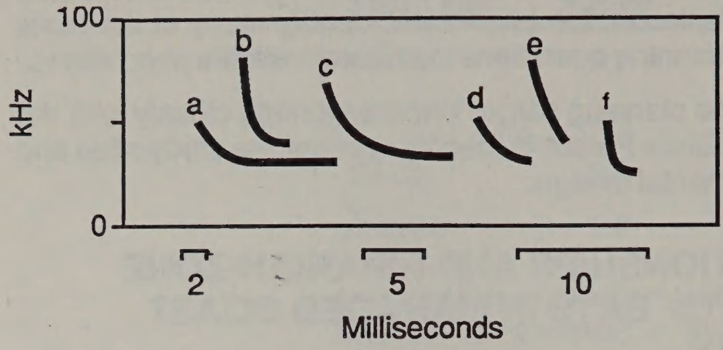


Figure 3. Patterns of frequency change over time in search-phase echolocation calls of selected bats occurring in the Oregon Coast Range: Lasiurus cinereus (a), Myotis volans (b), Eptesicus fuscus (c), Myotis thysanodes (d), Myotis californicus (e), and Antrozous pallidus (f). Figure modified from Fenton and Bell (1981).

References

Fenton, M.B., and G.P. Bell. 1981. Recognition of species of insectivorous bats by their echolocation calls. *Journal of Mammalogy* 62:233-243.

Thomas, D.W. 1988. The distribution of bats in different ages of Douglas-fir forests. *Journal of Wildlife Management* 52:619-624.

ADAPTATION OF A FOREST SUCCESSION AND WILDLIFE HABITAT MODEL TO MANAGED COAST RANGE FORESTS

(Andrew J. Hansen—Department of Biology, Montana State University, Bozeman; Steve Garman—OSU Department of Forest Science)

An emerging ecological paradigm holds that the well-being of humans is closely coupled with the well-being of ecological systems. In the interest of developing sustainable ecological and human communities, new silvicultural strategies are being devised and implemented on federal forest lands in the Pacific Northwest. Two important stand-level variables of these new regimes are harvest rotation age and retention of live trees in harvest units.

Ecologists have suggested that maintaining longer rotations and retaining more live trees after harvest will create stand-structure patterns in managed forests similar to those in natural forests, and that these techniques will promote long-term ecological productivity and biological diversity. Forest economists and others, however, are concerned that such an approach to forest management might reduce wood production below acceptable levels.

We used the forest model ZELIG to simulate the long-term responses of several ecological and economic variables to nine green-tree retention levels and four rotation lengths. The results of the ZELIG model on forest structure and composition were fed into a forest economics model that calculated the net value of wood products in 1989 dollars. The simulated stand data were also linked with regression equations to predict the

densities of 18 bird species as a function of tree size-class distribution. Five replications of each treatment were run for the 240-year simulation period.

The computer simulations indicated that stand-scale silvicultural manipulations strongly influence long-term forest structure and composition, and that these, in turn, have important consequences for forest productivity, both ecological and economic, and for bird habitat dynamics. As expected, stands produced by clearcutting remained substantially higher in tree density and lower in tree size variation than the initial old-growth forest (Figure 4, Figure 5). Intermediate levels of canopy tree retention at harvest, in contrast, resulted in stands with tree densities and diameters similar to those in the initial old-growth forest.

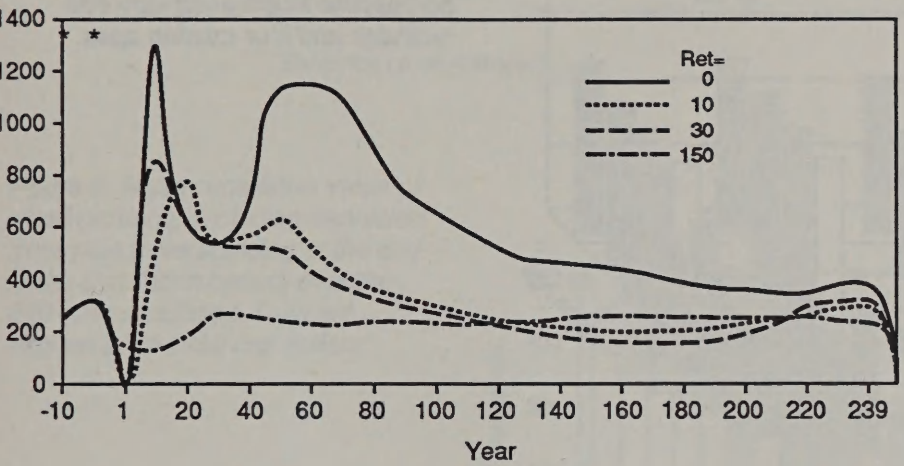


Figure 4. Mean density of trees for four levels of canopy tree retention over a 240-year rotation. Years -10 and 0 represent years 480 and 500, respectively, of the simulated pre-treatment forest. Data values differed significantly among retention levels for all time steps except those denoted with an asterisk.

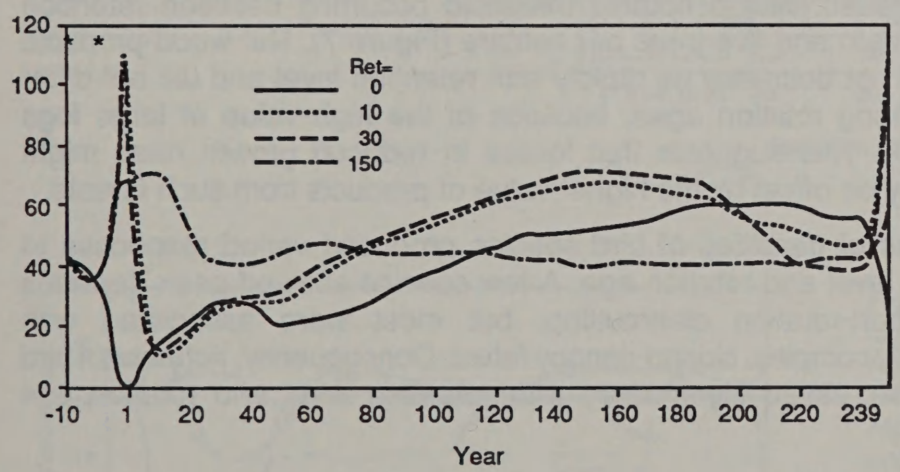


Figure 5. Mean tree dbh for four levels of canopy tree retention over a 240-year rotation. Years -10 and 0 represent years 480 and 500, respectively, of the simulated pre-treatment forest. Data values differed significantly among retention levels for all time steps except those denoted with an asterisk.

Importantly, variation in dbh for intermediate retention levels remained below that in the initial stand for over 200 years, which suggests that retaining multiple size classes of trees at harvest is necessary to produce stand structures typical of natural forests. Another important finding was that mean dbh under clearcutting exceeded that in the initial forest after about 120 years and increased beyond the intermediate retention treatments at about 200 years.

Overall, the data suggest that canopy tree retention enhances structural complexity beyond that of clearcutting for nearly 200 years following harvest. Higher levels of retention better approximate old-growth forest structure. Beyond 200 years after harvest, structural complexity of all the retention levels converged near that of the initial old-growth forest.

Tree species composition was strongly related to retention level and rotation age. The shade-intolerant Douglas-fir lost dominance to the more shade-tolerant species under intermediate retention levels and longer rotations (Figure 6).

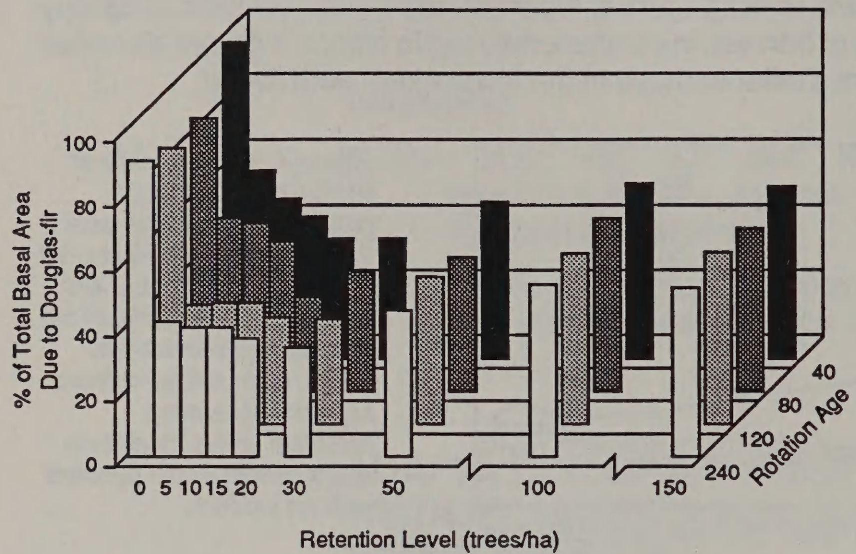


Figure 6. Mean contribution of Douglas-fir to total basal area at year 240 (prior to final harvest) across nine levels of canopy tree retention and four rotation ages.

Wood production was significantly reduced as retention level and rotation age increased, with a notable threshold occurring between retention levels of zero and five trees per hectare (Figure 7). Net wood-products value did not decrease as rapidly with retention level and did not differ much among rotation ages, because of the high value of large logs (Figure 8). This suggests that losses in reduced growth rates might eventually be offset by the higher value of products from such forests.

Simulation of densities of bird species produced varied responses to retention level and rotation age. A few species showed peak densities under short-rotation clearcutting, but most were associated with structurally complex, closed-canopy forest. Consequently, richness of bird species increased significantly with retention level and rotation age (Figure 9).

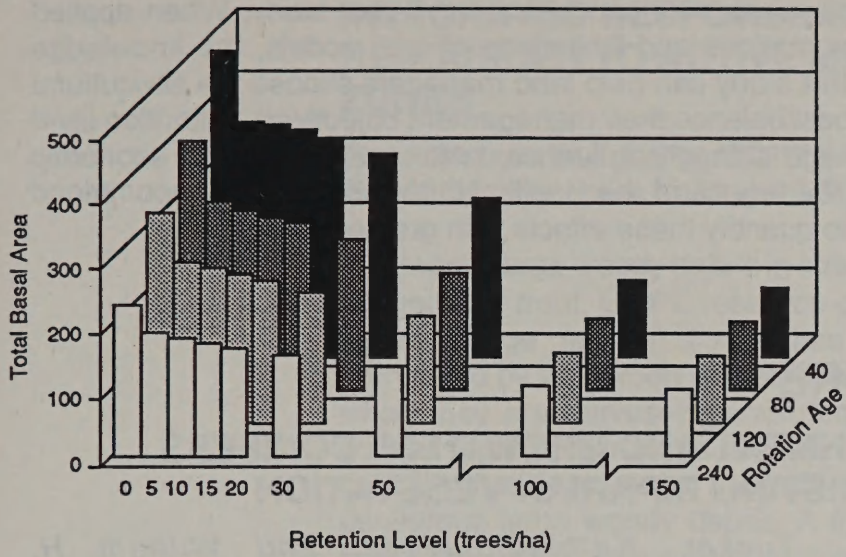
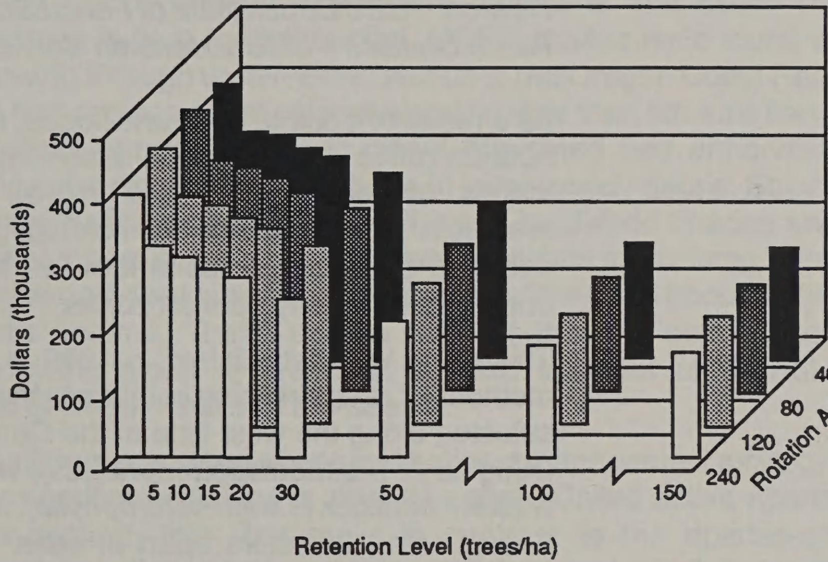


Figure 7. Mean cumulative wood production (total basal area of harvested trees plus trees standing at the end of the simulation period) over the 240-year simulation.

Figure 8. Mean cumulative value of wood products (including harvested trees plus trees standing at the end of the simulation period) over the 240-year simulation. Data are expressed in 1989 real dollars.



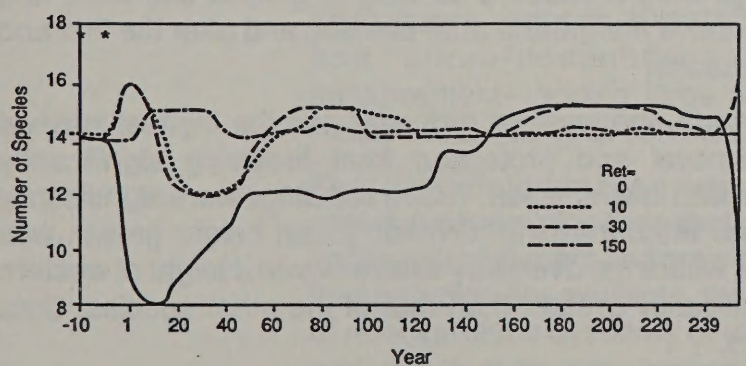


Figure 9. Simulated bird species richness for four levels of canopy tree retention over a 240-year rotation. Years -10 and 0 represent years 480 and 500, respectively, of the simulated pre-treatment forest. Data values differed significantly among retention levels for all time steps except those denoted with an asterisk.

This simulation experiment concludes our 3-year study. When applied within the assumptions and limitations of our models, the knowledge derived from this study can help land managers choose the silvicultural regimes that best balance their management objectives. Retention level and rotation age strongly influence both ecological and economic responses in the forests of the Pacific Northwest, and we recommend further study to quantify these effects with greater precision.

RIPARIAN SILVICULTURE

ESTABLISHMENT AND GROWTH OF CONIFERS UNDER EXISTING RIPARIAN VEGETATION

(Gabriel F. Tucker, Kathleen Maas, and William H. Emmingham—Adaptive COPE; Barbara Schrader and Michael Newton—OSU Department of Forest Science; Michael J. Cloughesy and Ralph Duddles—OSU Extension Service)

As a result of logging, fires, and floods, the conifers that once dominated riparian zones in the Oregon Coast Range have been largely replaced by stands of red alder (*Alnus rubra*). Few conifers have become reestablished beneath the alder canopy, and thus coniferous large woody debris, a desirable component of fish habitat in streams, is essentially unavailable in many riparian zones.

This study was established in 1989 to determine the most successful methods of reestablishing conifers in these riparian zones. Six sites were selected along the west side of the Coast Range. Four conifer species, Douglas-fir *(Pseudotsuga menziesii)*, western redcedar *(Thuja plicata)*, western hemlock *(Tsuga heterophylla)*, and grand fir *(Abies grandis)* were underplanted 2 meters apart in each subplot. Half the trees in each planting were protected from browsing with Vexar™ tubing. The overstory was either removed by girdling and herbicide injection or left untreated as a control. Seedlings were measured for height, ground diameter, and diameter at 15 cm above the ground after planting and after the first and second growing seasons.

After 2 years of growth, the western redcedar had the highest survival rate. Overstory removal and protection from browsing significantly increased height growth in all species. Tubed seedlings were significantly taller than seedlings without tubing. Overall, mean height growth was significantly greater where the overstory was removed. Height of western redcedar was significantly greater than that of the other species. Data collection continues.

INTEGRATED RESPONSE OF MULTIPLE FOREST RESOURCES TO ACTIVE MANAGEMENT IN RIPARIAN ZONES

(Arne Skaugset—Adaptive COPE; Michael Newton—OSU Department of Forest Science; Loren Kellogg—OSU Department of Forest Engineering)

In general, large woody debris in streams improves habitat conditions for salmon and trout. COPE research on the ecology and management of Coast Range riparian zones has found that these areas can be dominated by hardwood overstories with shrub understories, especially when they are harvest-regenerated. In these types of riparian areas, conifer regeneration is usually nonexistent or suppressed, raising the concern that if left alone, they will not become source areas for future coniferous large woody debris. A further concern is that a fixed-width buffer strip with management exclusion will exacerbate the problem.

Research by COPE and other scientists suggests that debris from coniferous trees is best for fish habitat. COPE studies have found that streams flowing through unharvested stands in the Oregon Coast Range had both a higher piece count of large woody debris than streams flowing through second-growth stands or mixed harvested and unharvested stands, and more than twice the volume of large woody debris. Streams flowing through conifer and mixed conifer and hardwood riparian areas had similar numbers of pieces of large woody debris as streams flowing through hardwood-dominated riparian areas, but they had about twice as much debris volume. These studies suggest that the abundance of conifers growing along a stream is a good indicator of the future abundance of woody debris in the stream.

This research has prompted efforts to develop a management strategy to get conifer seedlings growing in riparian zones. Called active riparian-zone management, this strategy is in contrast to the riparian-area management paradigm of the past several decades, which holds that riparian areas receive no active management. Active riparian-zone management encompasses two areas of interest: 1) riparian silviculture—methods of establishing and growing conifers in hardwood- and shrub-dominated riparian areas; and 2) stream enhancement—adding large woody debris to streams to improve the amount and quality of fish habitat.

The COPE Program has several riparian-silviculture projects in progress, aimed at determining the effects of overstory and understory manipulation on the establishment and growth of conifers. Only preliminary results from these studies are available, but they indicate that, in general, some level of removal of the overstory or understory is required for optimum survival and growth of conifer seedlings. Several stream-enhancement projects are also installed. These have the goal of determining the effects of piece size, orientation, and complexity of woody debris on fish habitat.

Last year, a comprehensive Adaptive COPE project was begun to bring both avenues of research, riparian silviculture and stream enhancement,

together on an operational scale, and also to add a third line of inquiry, the harvest-engineering aspects.

The project consists of three harvest units located on industrial forest land in the central Oregon Coast Range (Figure 10). The streams flowing through the harvest units are debris-poor. The riparian areas associated with the streams have alder-dominated overstories with shrub-dominated understories, and they lack natural regeneration of conifers. The harvest unit extends along at least 2,000-ft of the main stem of each study stream. At the upstream and downstream ends of the 2,000 ft study reach, 300-ft-long openings were installed (Figure 11). Between the 300-ft openings, 100-ft-wide buffer strips were left along each side of the stream. An additional 600-ft opening was cut on the stream or on an adjacent tributary.

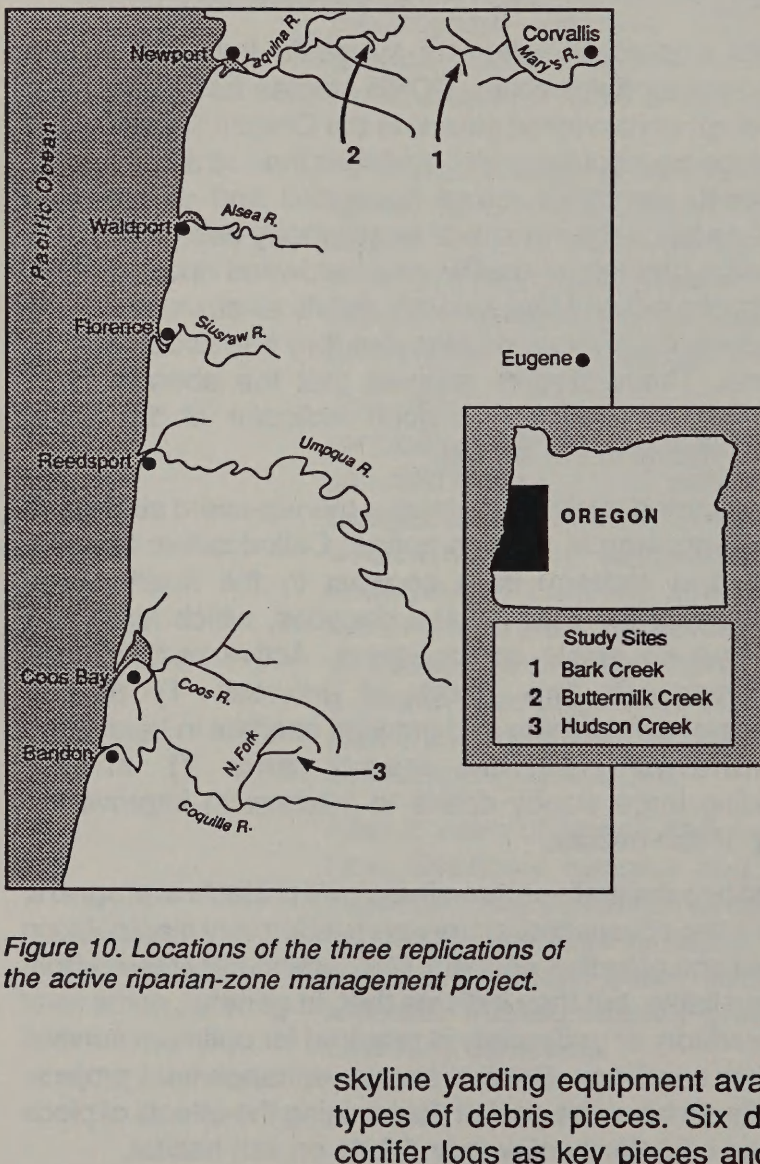


Figure 10. Locations of the three replications of the active riparian-zone management project.

The riparian-silviculture component of the study is being carried out under the direction of Mike Newton, OSU Department of Forest Science, as a special CRAFTS (Coordinated Research on Alternative Forestry Treatments and Systems) project. Three stocktypes of three conifer species will be planted in the 300- and 600-ft openings in the riparian area. The effect of opening size and species and stocktype of seedling on seedling survival and growth will be determined. Stream temperature and streambank disturbance from logging directly adjacent to the stream also will be monitored.

The stream-enhancement component of the project is under the direction of Arne Skaugset of the Adaptive COPE team. During harvesting, complex woody-debris accumulations will be installed in the streams within the 300-ft openings. These will consist of a single large piece of wood and three to six smaller pieces. Two types of large woody debris will be used: large conifer logs yarded from the upslope harvest unit and large alders pulled over with the rootwad intact. The skyline yarding equipment available on site will be used to install both types of debris pieces. Six debris accumulations—three using large conifer logs as key pieces and three using alders—will be installed in each stream. Stream habitat surveys will be carried out and topographic maps of the stream channel will be made annually to track the effects of the debris accumulations on fish habitat.

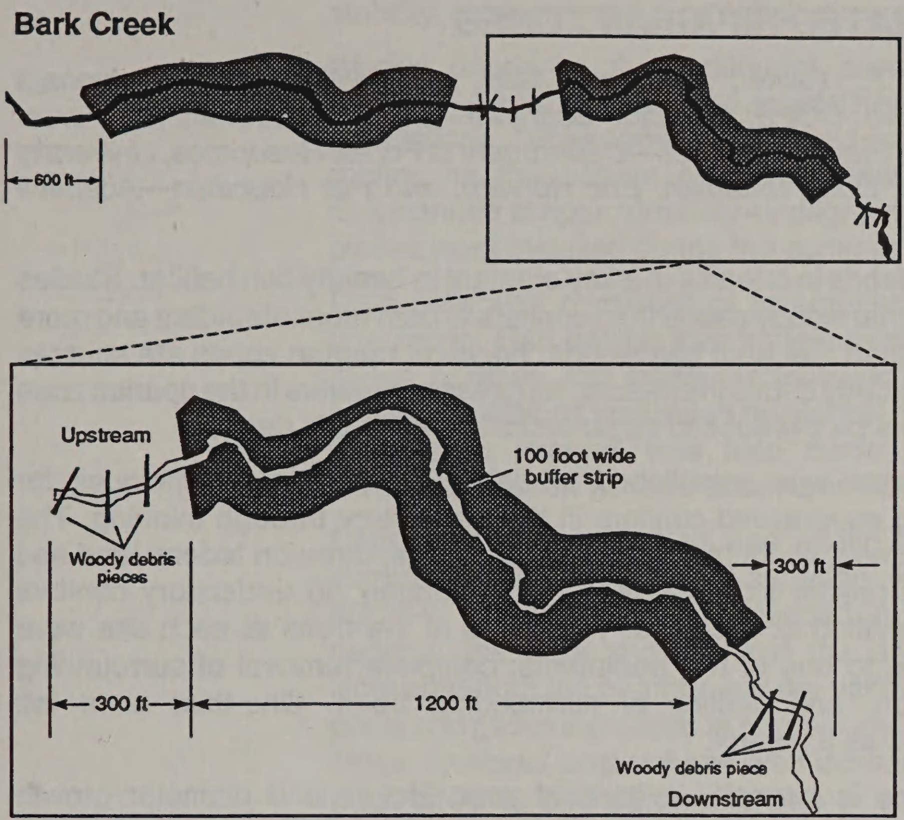


Figure 11. General layout of openings and buffer strips for each replication of the project.

The logging-operations research component of the study is a Fundamental COPE project under the direction of Loren Kellogg, OSU Department of Forest Engineering. The research includes determining the planning requirements and cost of harvesting hardwoods from the riparian openings and determining the cost of installing stream-enhancement structures during the logging operation. Time studies will be completed to determine logging-operation differences within 300- and 600-ft openings, in areas adjacent to the 100-ft streamside buffers, and within the upslope harvest area. Time studies also will be completed during stream-enhancement activities.

Two of the replications are completely installed. All the requisite logging engineering data have been collected, including time studies for the logging and debris-placement operations. Seedlings were planted this past winter (1992-93) in the openings in the riparian zones. The third replication will be installed during the summer of 1994.

This project has dominated the work of the Adaptive COPE team over the past year. The bulk of the initial work is now complete; we have located the study sites, made the preharvest topographic maps, conducted the stream surveys, carried out the harvest operation, and installed the stream temperature instrumentation. All this was a major undertaking, requiring coordination among the landowners, the logger, the three principal scientists, and a host of state regulatory agencies.

RELEASE OF SUPPRESSED CONIFERS IN ALDER-DOMINATED RIPARIAN ZONES

(Gabriel F. Tucker, Kathleen Maas, and William H. Emmingham—Adaptive COPE; Barbara Schrader—OSU Department of Forest Science; Steve McConnell—Department of Forest Resources, University of Idaho; Doug Bateman, Eric Horvath, and Pat Hounihan—Adaptive COPE)

Woody debris in streams is a key element in healthy fish habitat. Studies indicate that woody debris from conifers is both more abundant and more durable than that from hardwoods. Because riparian zones are sources of large woody debris in streams, suppressed conifers in the riparian zone should not be overlooked as potential future woody debris.

This project was established to determine the best techniques for releasing suppressed conifers in the understory through thinning. The study is being conducted in six riparian areas, three on federal land and three on private industrial land. Approximately 50 understory conifers were identified at each site. Two-thirds of the trees at each site were subjected to one of two treatments: complete removal of surrounding vegetation, and girdling of surrounding trees. One-third were left untreated as a control.

The study is currently in its third year. Height and diameter growth response will be analyzed after data are collected this year. Preliminary data from second-year results show that the relatively shade-intolerant Douglas-fir had a higher mortality rate than the more shade-tolerant western hemlock or western redcedar. All the Douglas-fir that died succumbed to the effects of competition and reduced light. Rodents (mountain beaver and beaver) were the main causes of mortality for the shade-tolerant species.

LARGE STREAM-BORNE WOODY DEBRIS

INFLUENCE OF WOODY DEBRIS PIECE SIZE AND ORIENTATION ON FUNCTION IN SMALL STREAMS

(Arne Skaugset—Adaptive COPE; Bob Bilby—Weyerhaeuser Co.; Jim Sedell—USDA Pacific Northwest Research Station)

Understanding of the role of large woody debris in forest streams has increased significantly over the last two decades. Research has shown that large woody debris improves fish habitat by increasing pool types and sizes, sediment storage, and local scour. However, simply knowing that "wood is good" is insufficient for making site-specific prescriptions that include the number and size of woody debris pieces required to maintain adequate aquatic habitat. The goal of this project is to help provide such information for Coast Range headwater streams by investigating the

effects of the size and orientation of large woody debris pieces on debris stability, stream channel morphology, and aquatic habitat.

Woody debris of three different sizes—8, 16, and 24 inches in diameter—were placed in two coastal headwater streams at two different orientations. "Spanners" were placed perpendicular to streamflow and resting on the bottom of the channel, and "ramps" were oriented downstream at approximately 45 degrees to streamflow. Thirty-six debris pieces were installed during the summer of 1989.

Data collection consisted of inventories of both fish habitat and fish population. Fish habitat inventories identified stream reaches as pools, glides, or riffles, and measured their width, length, and depth. A census of fish populations was taken by electro-shocking. A topographic map of the stream channel was also made so that changes in channel morphology, such as local scour and fill, could be monitored.

Data have been collected and analyzed for the project through the summer of 1991. The project summary was presented in *COPE Report* 4(2):4-6, and was also summarized in last year's *Annual Report*. In general, the data showed that the addition of large woody debris increased both the number and the variety of aquatic habitat units. Both pools and glides increased in number and surface area at the expense of riffles. Residual pool volume also increased. Large spanners were the most effective orientation and size of debris for creating pool volume. Because fish were primarily associated with pool habitat, fish numbers increased where large woody debris pieces created pools.

No further data collection or analysis has been carried out since 1991 because all available resources have been channeled into getting the comprehensive active riparian-zone management project off the ground. Now that this project is installed, further study of the debris installations is anticipated.

Results from this project should be helpful for predicting habitat improvement when debris is added to streams as a part of enhancement projects or for modeling the effect of natural recruitment of riparian trees. This project should also provide information for writing site-specific prescriptions for riparian areas that will maintain or improve aquatic habitat while allowing some timber harvest along coastal streams.

LARGE WOODY DEBRIS AND FISH HABITAT IN COAST RANGE STREAMS

(Arne Skaugset—Adaptive COPE; Ron Rhew—U.S. Fish and Wildlife Service, Portland; Tom McMahon—Department of Biology, Montana State University, Bozeman)

Awareness of the beneficial role played by large woody debris in salmon and trout habitat has increased substantially over the past two decades. As a result, state and federal regulations now require protection for woody debris in fish-bearing streams and retention of standing conifers adjacent

to fish-bearing streams after timber harvesting to provide future large woody debris. Forestry and fisheries management agencies have also initiated programs to add large woody debris to debris-poor streams. However, no criteria yet exist for determining desired amounts and sizes of debris or for developing and evaluating debris management plans.

This project attempts to help fill this information gap by assembling and analyzing both published and unpublished data on large woody debris in the Oregon Coast Range. The project is essentially complete: the data have been collected, analyzed, and summarized. A summary of the work was presented in *COPE Report* 4(3):3-5 and in last year's *Annual Report*. The only task remaining is the preparation of the final report, which is in production and should be completed, reviewed, and submitted for publication soon.

REFORESTATION

COMMERCIAL THINNING AND UNDERPLANTING TO ENHANCE STRUCTURAL DIVERSITY OF YOUNG DOUGLAS-FIR STANDS

(Gabriel F. Tucker, John P. Hayes, and William H. Emmingham—Adaptive COPE; Richard McCreight—OSU Department of Forest Science; Stuart Johnston—USDA Forest Service, Siuslaw National Forest; Don Minore, Sam Chan, and Peyton W. Owston—USDA Forest Service, Pacific Northwest Research Station)

Wildlife biologists and forest ecologists are beginning to understand the relationship between stand structure and forest ecosystem function. Although specific stand-structure needs are still unknown for species such as the northern spotted owl, structural patterns resembling those of old-growth forests have been suggested. Present knowledge of stand-density dynamics suggests that young stands can be manipulated to provide many of these old-growth habitat characteristics in a relatively short time frame.

Thinning of young stands to low densities will stimulate rapid growth of residual dominant trees and encourage development of the understory. However, current stand-dynamics data are too sparse to reliably project the development of such stands over time. This project will establish and monitor an array of stand-density management regimes designed to create multi-storied stands. Its goal is to begin to form a base of knowledge for determining how quickly forest stands that are partially harvested and underplanted improve as habitat for wildlife species associated with old-growth or late-successional forests.

Our approach is to thin young (approximately 30-year-old) plantations to a variety of densities, including average (100 trees per acre), wide (60 trees per acre), and very wide (30 trees per acre). Control areas with 200-400 trees per acre will be left unthinned. In addition, hemlock and Douglas-fir will be planted in the understory of all areas to test their

contribution to the development of vertical structure. Alder will be underplanted in *Phellinus weirii* root-rot pockets. In each of the density treatments, six conifers (Douglas-fir, western hemlock, western redcedar, grand fir, Sitka spruce, and Pacific yew) and two hardwoods (red alder and bigleaf maple) will be tested for survival and growth in underplanting trials. Development of understory vegetation, changes in microclimate, and development of overstory crowns will all be monitored in cooperation with the PNW Research Station and the Siuslaw National Forest.

These various overstory densities and understory management regimes will provide a wide array of vertical structures at various time intervals. We believe that some of them will result in old-growth-like habitat much sooner than would occur in unmanaged stands. All the manipulations are being done at commercial thinning age so that the operations will be economically viable.

This study should provide key information that will enable forest managers to move toward an ecosystem approach to management, one focusing on sustaining processes that keep ecological systems diverse, healthy, and productive. The study will also provide basic information for landowners who wish to manage stands with increased structural diversity over a long rotation.

EDUCATION

To ensure that research information developed by COPE is quickly available to a broad audience, Adaptive COPE team members publish scientific papers, reports, and a quarterly newsletter; organize workshops; make formal presentations; lead field tours, and consult with cooperators. Forestry Extension agents help in bringing COPE research findings and activities to the attention of the general public via their county Extension newsletters and workshops.

NEWSLETTER

The *COPE Report* was mailed to over 2,100 subscribers this year. This report rapidly disseminates research findings, announces forthcoming educational opportunities, and highlights recent publications and topics of interest. The goal of the newsletter is to consistently and effectively inform cooperators and other interested persons about COPE activities and about general developments in resource management. This year's four issues are reprinted in the Appendix to this report, along with the Summer 1992 issue (5:3).

PUBLICATIONS AND REPORTS

Kellogg, L., S. Pilkerton, and A. Skaugset. 1993. Harvesting for active riparian zone management and the effects on multiple forest resources. *In* Environmentally Sensitive Forest Engineering: Proceedings of the Council on Forest Engineering (COFE) Annual Meeting. August 8. Augusta, Georgia.

Skaugset, A.E. 1992. Slope stability and general hydrology research. *In* Forest Soils and Riparian Zone Management: The Contributions of Dr. Henry A. Froehlich to Forestry. Proceedings of a workshop. November 18. LaSells Stewart Center, Oregon State University, Corvallis.

Skaugset, A.E., H.A. Froehlich, M.R. Pyles, and K. Lautz. 1992. Timber harvest on landslide-prone sites; the effectiveness of headwall leave areas. *In* Forest Soils and Riparian Zone Management: The Contributions of Dr. Henry A. Froehlich to Forestry. Proceedings of a workshop. November 18. LaSells Stewart Center, Oregon State University, Corvallis.

Tucker, G.F., and J.R. Powell. 1992. An improved canopy access technique. *Arboricultural Journal* 16(4). Reprinted from *Northern Journal of Applied Forestry* 8:1 (1991).

Tucker, G.F., J.P. Lassoie, T.J. Fahey, and B.F. Chabot. 1992. Within- and between-tree variation of xylem-borne sucrose production in

stand-grown sugar maple (*Acer saccharum* Marsh.). Abstract. P. 133 *in* Proceedings of the 12th North American Forest Biology Workshop: The Role of Physiology and Genetics in Forest Ecosystem Research and Monitoring. August 17-20. Sault Ste. Marie, Ontario.

Tucker, Gabe. 1993. Growing trees for fish. *Coast Ranger* 8:5.

Tucker, G.F., and J.P. Lassoie. 1993. Crown architecture of stand-grown sugar maple (*Acer saccharum* Marsh.) in the Adirondack Mountains. *Tree Physiology* 13:3.

WORKSHOPS AND FIELD TOURS

FOREST SOILS AND RIPARIAN ZONE MANAGEMENT: THE CONTRIBUTIONS OF DR. HENRY A. FROEHLICH TO FORESTRY

November 18, 1992. LaSells Stewart Center, Oregon State University, Corvallis. 110 participants.

This workshop was organized by Arne Skaugset and the Forest Engineering Department of the OSU College of Forestry to honor Dr. Froehlich, who retired in 1992 after 22 years on the College faculty. Several of his former students made presentations at the workshop.

FOREST SOILS AND RIPARIAN ZONE MANAGEMENT: THE CONTRIBUTIONS OF DR. HENRY A. FROEHLICH TO FORESTRY

PROGRAM HIGHLIGHTS

November 18, 1992

Keynote address: George W. Brown, Dean, College of Forestry.

Soil compaction research: Pete Cafferata, Forest Hydrologist, California Department of Forestry and Fire Protection.

General hydrology and slope stability research: Arne Skaugset, Forest Hydrologist, Adaptive COPE.

Woody debris in streams and riparian zone management research: Dale McGreer, Resource Hydrologist, Potlatch Corp., Lewiston, Idaho.

His own remarks: Henry A. Froehlich, Professor of Forest Engineering, College of Forestry, Oregon State University.

COMMERCIAL THINNING AND UNDERPLANTING TO ENHANCE DIVERSITY OF FORESTS AND STREAMS

One-day field tours co-sponsored by Adaptive COPE and the Siuslaw National Forest. Dec. 17, 1992; repeated April 22 and June 30, 1993, because of popular demand. 75-plus participants per tour.

New experiments have been installed to investigate commercial thinning techniques for promoting structural diversity in upslope and riparian forests. The aim of this field forum, organized by Bill Emmingham and Gabe Tucker, was to showcase these experiments in their early stages and to facilitate discussions of the experimental techniques, management implications, and underlying issues and assumptions. After a 1-hour lecture, participants visited three field sites illustrating how young plantations or hardwood-dominated riparian zones can be manipulated to enhance structure for fisheries or wildlife purposes. The wide-ranging backgrounds of the participants led to lively discussions.

COMMERCIAL THINNING AND UNDERPLANTING TO ENHANCE DIVERSITY OF FORESTS AND STREAMS

SPEAKERS

Dave Braley, USDA Forest Service, Mapleton
Sam Chan, PNW Station, Corvallis
Bill Emmingham, OSU, Corvallis
Jim Furnish, USDA Forest Service, Corvallis
Joan Hager, OSU, Corvallis
John Hayes, Adaptive COPE, Newport
Bill Helphinstine, USDA Forest Service, Mapleton
Stu Johnston, USDA Forest Service, Mapleton
Dan Karnes, USDA Forest Service, Mapleton
Loren Kellogg, OSU, Corvallis
Robert Mahon, logging contractor, Corvallis
Paul Mansur, Koller USA Corp., Portland
Bob Metzger, USDA Forest Service, Corvallis
Don Minore, PNW Station, Corvallis
Dan Segotta, USDA Forest Service, Mapleton
Gabe Tucker, Adaptive COPE, Newport

ANNUAL BRIEFING FOR CONGRESSIONAL AND GUBERNATORIAL STAFF

A field tour for staff members of the Oregon congressional delegation and the Governor's Office. April 29, 1993. Siuslaw National Forest and BLM land in the Coast Range.

Members of the natural-resource staffs of Senators Mark Hatfield and Bob Packwood, Representatives Peter DeFazio, Mike Kopetski, and Ron Wyden, and Governor Barbara Roberts were invited to take a close-up view of ongoing riparian research in the Coast Range. The tour showcased several COPE research projects dealing with the role of large woody debris in streams, landslides, the impact of red alder and salmonberry in riparian zones, and the effects of management practices such as commercial thinning on fish and wildlife habitat.

LINCOLN COUNTY COMMUNITY LEADERS FIELD TRIP

A field trip sponsored by OSU Extension with support from the Siuslaw National Forest. August 18, 1993. About 53 participants.

The event was titled, "The Future of Natural Resource Management in Lincoln County: How to Make a Living and Protect Resources." Arne Skaugset represented Adaptive COPE and joined participants from Bureau of Land Management, Oregon Department of Fish and Wildlife, Lincoln County Commissioners, Georgia-Pacific, Hatfield Marine Science Center, Oregon Small Woodlands Association, city managers from Lincoln County, the Oregon Department of Environmental Quality, staff of U.S. Representative Mike Kopetski and Oregon Representative Hedy Rijken, the Oregon Farm Bureau, several soil and water conservation districts, and others. The tour highlighted the role of estuaries and oceans, federal forests, industrial lands, agricultural lands, and small woodlands.

CREATING A FORESTRY FOR THE 21ST CENTURY

A symposium co-hosted by COPE. August 24-26, 1993. Portland, Oregon.

The symposium was designed to bring together the growing body of research, information, and ideas on innovative forestry, to discuss concepts and practices in ecosystem management, and to explore the implications for forest management, planning, and policy.

REGIONAL ALTERNATIVE SILVICULTURE CONFERENCE

A COPE-sponsored workshop held within the symposium, Creating a Forestry for the 21st Century. August 24, 1993. Portland, Oregon.

The workshop featured talks and discussion on the topic of young-stand management in the Pacific Northwest. Speakers, including Adaptive COPE's Gabe Tucker, addressed various projects underway in the region wherein commercial thinning and underplanting are being used along with various other cultural practices to promote structural diversity of forests and habitat for wildlife.

PRESENTATIONS

Adaptive COPE team. Restoration ecology of coastal riparian areas: an applied approach. Poster presented at the symposium, Creating a Forestry for the 21st Century. August 24-26, 1993. Portland, Oregon. Also presented at the Conference on Sustainable Ecological Systems. July 13-15, 1993. Flagstaff, Arizona.

Adaptive COPE team. COPE—Coastal Oregon Productivity Enhancement Program. Poster presented at the symposium, Creating a Forestry for the 21st Century. August 24-26, 1993. Portland, Oregon.

Hansen, Andrew, and Steve Garman. 1992. A test of ecological forestry, wood production, and habitat diversity under alternative silvicultural regimes. Annual Meeting of the Ecological Society of America, August 10-13. Honolulu, Hawaii.

Hayes, John P. 1992. Genetics, evolution, and biodiversity. Lecture for physical anthropology class at Oregon Coast Community College. Oct. 5. Newport.

Hayes, John P. 1992. Coarse woody debris. Stewardship of Fisheries and Wildlife workshop. Nov. 16. Corvallis, Oregon.

Hayes, John P. 1992. Stimulating development of late seral stage characteristics: spotted owl considerations. Commercial Thinning and Underplanting to Enhance Diversity of Forests and Streams. Dec. 17. Mapleton, Oregon.

Hayes, John P. 1993. Interview on Northwest Timber Network, a radio program aired on five Eugene-area stations. Jan. 6. Eugene, Oregon.

Hayes, John P. 1993. Genetic considerations for landscape management. Guest lecture for Forest Science 453-553 class, Managed Forests and Wildlife Interactions. Jan. 27. Department of Forest Science, College of Forestry, Oregon State University, Corvallis.

Hayes, John P. 1993. Use of molecular genetics to address conservation problems. Presentation at weekly science seminar. Feb. 26. Southern Oregon State College, Ashland.

Hayes, John P. 1993. Stimulating development of late seral stage characteristics: spotted owl considerations. Commercial Thinning and Underplanting to Enhance Diversity of Forests and Streams. April 22 and June 30. Mapleton, Oregon.

Hayes, John P. 1993. Conservation biology: principles and applications in forest environments. Forest Science 691C course organized and taught spring quarter. Department of Forest Science, College of Forestry, Oregon State University, Corvallis.

Hayes, John P., Michael Castellano, Eric Horvath, and Pat Hounihan. 1993. Mycophagy of Townsend's chipmunks *(Tamias townsendii)*

in different aged forest stands in the Oregon Coast Range. Poster presented at the 73rd Annual Meeting of the American Society of Mammalogists. June 21. Western Washington University, Bellingham.

Schrader, Barbara A., Jerry F. Franklin, Jon R. Martin, and Paul Alaback. 1992. Successional dynamics of riparian spruce forests in southeast Alaska. Poster presented at the Annual Meeting of the Ecological Society of America. August 10-13. Honolulu, Hawaii.

Skaugset, Arne E. 1992. Summary of ongoing Adaptive COPE research on active management in riparian zones, including riparian silviculture and stream enhancement. Annual Retreat of the Forestry Committee, Confederated Tribes of the Grand Ronde. Sept. 18. Redmond, Oregon.

Skaugset, Arne E. 1992. A tale of timber harvesting, slope stability, and headwall leave areas; or, why Hank Froehlich really retired. Forest Engineering 507 seminar. Nov. 11. Department of Forest Engineering, College of Forestry, Oregon State University, Corvallis.

Skaugset, Arne E. 1992. Slope stability and general hydrology research. Forest Soils and Riparian Zone Management: The Contributions of Dr. Henry A. Froehlich to Forestry. Nov. 17. Oregon State University, Corvallis.

Skaugset, Arne E. 1993. Effect of woody debris piece size and orientation on aquatic habitat. Annual Briefing for Congressional and Gubernatorial Staff. April 29. Siuslaw National Forest.

Skaugset, Arne E. 1993. Adaptive COPE active riparian zone management project, update and briefing. Less than Desirable Conditions: Field Tour of Oregon Department of Forestry. July 9. Central Oregon Coast Range.

Tucker, G.F., J.P. Lassoie, T.J. Fahey, and B.F. Chabot. 1992. Within- and between-tree variation of xylem-borne sucrose production in stand-grown sugar maple (*Acer saccharum* Marsh.). 12th North American Forest Biology Workshop: The Role of Physiology and Genetics in Forest Ecosystem Research and Monitoring. Aug. 17-20. Sault Ste. Marie, Ontario.

Tucker G.F. 1992. Management practices of western hardwoods: can research provide improved management options? Western Hardwoods: Making a Stand for Economic Development. World Forestry Center Symposium. Oct. 7. Portland, Oregon.

Tucker, G.F. 1992 and 1993. Project overview and the use of ORGANON runs for predicting overstory response. Commercial Thinning and Underplanting to Enhance Diversity of Forests and Streams. Dec. 17, 1992; April 22 and June 30, 1993. Mapleton, Oregon.

Tucker, G.F., S.R. Johnston, W.H. Emmingham, and K.G. Maas. 1993. Simulated stand dynamics of young Douglas-fir plantations thinned

to enhance structural diversity. 66th Annual Meeting of the Northwest Scientific Association. March 24-27. LaGrande, Oregon.

Tucker, Gabe, and Stu Johnston. 1993. The Cataract thinning experiment: an example of stand-level ecosystem management. Ecosystem Management Workshop for Siuslaw and Willamette National Forests. April 5. Corvallis, Oregon.

Tucker, G.F. 1993. Old-growth restoration in the Oregon Coast Range. Silvicultural Systems Workshop. British Columbia Forest Service, Research Branch. April 6. Vancouver.

CONSULTATION

Adaptive COPE's location in Newport means staff members have ready access to Coast Range resource managers. This leads to informal contacts that provide an important and effective way of exchanging information. Throughout COPE's sixth year, Adaptive COPE team members have participated in many informal discussions, field trips, and impromptu meetings. These contacts will continue to be a significant part of the Adaptive COPE goal of transferring information among researchers, managers, and the general public.

Skaugset, Arne E. and Gabe Tucker. 1992. Riparian Inventory Planning workshop. South Slough National Estuarine Research Reserve. Oregon Division of State Lands and National Oceanic and Atmospheric Administration. Charleston, Oregon.

Tucker, Gabe, Arne Skaugset, and Ralph Duddles (OSU Extension Forestry agent, Coos and Curry Counties). 1993. A riparian management plan and silviculture experiment for the Wagner Ranch, Curry County.

ORGANIZATIONAL ACTIVITIES

The Adaptive COPE team was involved in a number of committees formed to address resource management topics related to various aspects of the COPE program. These assignments included:

- Canopy Access Steering Committee, Olympic Natural Resources Center, University of Washington (G. Tucker).
- Steering Committee for the symposium, Creating a Forestry for the 21st Century. Olympic Natural Resources Center, University of Washington (G. Tucker).
- COPE Science Committee (J.P. Hayes and G. Tucker).

ADAPTIVE COPE SCIENTIFIC STAFF

Bill Emmingham, Adaptive COPE's silviculturist, received a doctorate in forest ecology from OSU in 1974. He joined the Adaptive COPE team in 1993. He is interested in the ecology and management of Pacific Northwest forests, including silvicultural systems, regeneration, density management, and agroforestry. He holds an appointment as associate professor in the Department of Forest Science, where he is responsible for continuing education and Extension programs.

John Hayes, Adaptive COPE's wildlife ecologist, received a doctorate in ecology and evolutionary biology from Cornell University in 1990. He joined the Adaptive COPE team in 1992. He is interested in the ecology of terrestrial vertebrates in the Pacific Northwest, genetics, conservation biology, and biostatistics. He holds an appointment as assistant professor in the Department of Forest Science at OSU.

Arne E. Skaugset, Adaptive COPE's forest hydrologist, has been with the Adaptive COPE team since 1988. He received a master's degree in forest hydrology at Oregon State University in 1980 and is now a doctoral candidate in forest engineering at OSU, with a major in forest hydrology and a minor in geotechnical engineering. He is interested in interactions of riparian zones and streams, slope stability, woody debris in streams, and active management of forested riparian zones. He holds an appointment as instructor in the Department of Forest Engineering at OSU.

Gabe Tucker, Adaptive COPE's silviculturist, recieved a doctorate in natural resources at Cornell University in 1990. He joined the Adaptive COPE team in 1991. He is interested in alternative silviculture, ecosystem science, interdisciplinary resource management, agroforestry, tree ecophysiology, and remote sensing/geographic information systems. He holds an appointment as assistant professor in the Department of Forest Science at OSU.

RESEARCH SUPPORT STAFF

Doug Bateman joined Adaptive COPE as a faculty research assistant in 1990. He received his bachelor's degree in science education from OSU in 1986. His professional interests are fisheries and silviculture.

Elizabeth Dent joined Adaptive COPE as a faculty research assistant in 1993. She received her master's degree in forest hydrology from OSU in 1993. Her professional interests include stream resource-related research and basin-level watershed management.

Eric Horvath joined Adaptive COPE as a faculty research assistant in 1989. He received a bachelor's degree in zoology from OSU in 1985. His professional interests are ornithology, silviculture, and fisheries.

Pat Hounihan joined Adaptive COPE in 1990 as a biological science research technician. His professional interests are wildlife ecology and hydrology.

Kathleen Maas joined Adaptive COPE in 1993 as a faculty research assistant. She received her master's degree in forest ecology from Michigan State University in 1992. Her professional interests are forest ecology, silviculture, and statistics.

PLANS FOR FISCAL YEAR 1994

RESEARCH

- Continue work on studies listed in this report

EDUCATION

- Publish four issues of the *COPE Report*.
- Prepare a manuscript on survey of land managers on forest road drainage.
- Co-sponsor and facilitate a meeting of the Regional Council on Silvicultural Activities.
- Conduct a symposium titled "The ecology and management of Oregon Coast Range forests: a mid-term COPE perspective."
- Co-sponsor and conduct a field tour on silviculture with the Western Forestry and Conservation Association.
- Continue consultations, field trips, and meetings with cooperators and the public.
- Continue to increase public awareness of the COPE Program through the media and public presentations.
- Continue to work closely with resource managers through office visits and field tours.
- Produce an Adaptive COPE *Annual Report* for FY 1994.

BUDGET SUMMARY FOR FY 1993

Expenditures	FY 93 (anticipated)[1]	FY 94 (requested)
Personnel (salaries, wages, and OPE)	$363,000	$408,250
Services and Supplies	57,000	75,000
Travel	41,500	50,000
Capital Costs (equipment, facilities)	19,000	20,000
Indirect Costs	15,000	20,000
Tuition Costs	2,100	0
Total	**$497,600**	**$573,250**

Revenues	FY 93 (anticipated)[2]	FY 94 (requested)
BLM Districts	$141,000	$144,000
National Forests	100,000	100,000
Industry	144,000	150,000
Oregon Department of Forestry	55,000	80,000
Counties	20,500	21,000
Oregon Department of Fish and Wildlife	5,500	5,500
Oregon Small Woodlands Association	200	300
City of Newport	0	1,000
U.S. Fish and Wildlife Service	5,000	5,000
Bureau of Indian Affairs	5,000	5,000
Carryover	242,795	221,395
Total	**$718,995**	**$733,195**

[1] Expenditures for September were estimated.

[2] Several contributions totaling $10,000 had not been received at the time this report went to press, although their receipt is anticipated.

APPENDIX

COPE REPORT

This is a newsletter highlighting COPE research activities, forthcoming educational opportunities, and recent publications and topics of interest. To receive it, write or phone:

Adaptive COPE Program
Hatfield Marine Science Center
2030 S. Marine Science Drive
Newport, Oregon 97365-5296
(503) 867-0220

COPE Report SURVEY RESULTS

In the Winter '91/Spring '92 issue of *COPE Report* (5:1&2), we included a reader survey to help us better understand what our readers wanted to see in the newsletter.

We asked eight questions. The first five were: 1) How do you rate the technical quality of *COPE Report* articles? 2) What is your opinion of the mix of disciplines offered? 3) What percentage of the information presented is useful? 4) How do you rank the use of illustrations and tables? 5) How do you rank the importance of photographs in the newsletter?

The next three questions called for responses of a more subjective nature: 6) Is there a specific edition (or article) of the *COPE Report* which you particularly liked or did not like? Please explain. 7) What would you like to see more of in the *COPE Report*? 8) Additional comments and suggestions?

We received 94 responses indicating that, in sum, readers are satisfied with the content and presentation of the *COPE Report*. Responses to the first five questions are presented on a table here. We also include a random sample of answers to the next three questions.

Question number	Poor (0-20%)	Fair (21-40%)	Satisfactory (41-60%)	Good (61-80%)	Excellent (81-100%)
1	0	02	13	54	31
2	01	04	19	52	24
3	05	21	34	35	05
4	0	08	24	54	14
5	12	17	35	33	03

Question 6

"Liked importance of rotting logs, value of forest litter, mycorrhizae, clearcut vs. thinning economics, research relating to greenbelt and riparian management."

"'Predicting amounts of blowdown' article (*COPE Report* 5:1&2, p. 7-9). Almost all articles are pertinent and important."

"I like any article that applies research data and knowledge to practical work in planning and management activities."

"Information on riparian management and wildlife very useful to my work."

"When using graphs, put everything on equal scale . . . . need to compare apples to apples."

"'Patterns of fish communities in the Alsea Watershed Study' (*COPE Report* 5:1&2, p. 10-12). I'm glad to see you building on and continuing research. More long-term studies are needed."

Question 7

"Application and comparison of results as in the FIR Report."

"Studies of spotted owls found in younger stands of timber; e.g., on the Elliott State Forest."

"True silviculture, where rate of growth, quality of wood, static vs. dynamic stand conditions, landscape-scale silviculture are prescribed."

" . . . articles that will assist in managing and protecting multiple resources. Would like to see some more articles on biodiversity."

"More experimental attention given to more radical approaches to

forest management; i.e., natural-selection forestry . . . This technique seems to successfully address both landscape- and stand-level diversity and therefore vertebrate and . . . invertebrate diversity. Over the long term (150-200 years) it probably maximizes wood production as well."

"I'd like to see some forest industry responses to some of the research-—how do the private forest managers regard COPE recommendations?"

Question 8

"I'm not 'metricized' yet (probably never will be). Would like to have English equivalents shown in brackets . . . Also would like an index of all *COPE Report* articles to make it easier to locate previous articles and studies."

"Too much emphasis on solutions only the government could afford."

"Put phone number for principal author at end of each article."

"COPE may not be unique, but its blend of disciplines and abstract vs. applied science deserves more paper. Program needs to put a fraction more of its resources into the publication."

"Quality has been good. Articles provide enough detail to be useful."

"The COPE Program is producing the best and most pertinent research for our region."

COPE Report

Coastal Oregon Productivity Enhancement Program

Promoting Integrated Management of Oregon's Coast Range Forests Through Research and Education

Volume 5, Number 3 Summer 1992

From the Program Manager

As the program moves into its seventh year, COPE scientists are starting six additional research studies. Endorsed by the COPE Advisory Council during their June 2nd meeting, these studies reflect the commitment of cooperators and scientists to seek answers to some of the most complex issues and questions facing land managers.

Two of these projects will address Coast Range fisheries including one which will develop an economic analysis of forest management and fisheries interactions, and another that will study the long-term response of resident cutthroat trout to forest harvest. Also included is an investigation of management policies for increasing recreation's contribution to the economies of Oregon Coast Range communities.

Three of the studies will involve stand manipulations including a study to explore new harvesting techniques in upland and riparian areas. A second will investigate integrated response of multiple forest resources to active riparian management, and the third will examine the use of commercial thinning to increase structural diversity in young Douglas-fir stands. These stand manipulations are consistent with the need to explore and develop silvicultural options that will enable managers to achieve the stand structural characteristics necessary to enhance multiple resources on upland and riparian sites. This is of particular importance to riparian areas, many of which lack conifer regeneration. In this regard, I draw your attention to the first article in this issue of the COPE Report by Barbara Schrader and others. In it she summarizes the second-year results of an Adaptive COPE study designed to find ways of establishing conifers in riparian areas dominated by a red alder overstory and a shrub understory.

This summer the Menasha Corporation became the newest cooperating member of the COPE Program. We welcome them and the expertise they bring to COPE from many years of conducting forestry operations in the Oregon Coast Range. This brings to 33 the number of cooperating organizations now involved in the COPE Program.

Steve Hobbs

IN THIS ISSUE

COPE Report

Editor: Gabe Tucker
Managing Editor: Skye Etessami
Wildlife Editor: John Hayes
Silviculture Editor: Gabe Tucker
Soils/Hydrology Editor: Arne Skaugset
Design & Graphics Editor: Gretchen Bracher
Copy Editor: Judy Starnes

RESEARCH SUPPORT

Doug Bateman
Eric Horvath
Pat Hounhan
Barbara Schrader

The *COPE Report* is produced quarterly by the Adaptive COPE Team. Because of space limitations, articles appear as extended abstracts. Results and conclusions may be based on preliminary data and/or analysis. Readers interested in learning more about a study should contact the principal investigator or wait for formal publication of more complete results. Comments and suggestions concerning the content of the *COPE Report* are welcomed and encouraged. To receive this free newsletter, contact Adaptive COPE, 2030 S. Marine Science Dr., Newport, OR 97365, (503) 867-0220. For specifics on the overall COPE Program, contact Steve Hobbs, COPE Program Manager, Forestry Sciences Laboratory, 3200 SW Jefferson Way, Corvallis, OR 97331, (503) 750-7426.

The COPE Program is a cooperative effort between Oregon State University's College of Forestry, the USDA Forest Service, Pacific Northwest Research Station, the USDI Bureau of Land Management, other federal and state agencies, forest industry, county governments, and the Oregon Small Woodland Association. The intent of the program is to provide resource managers and the public with information relative to the issues and opportunities associated with the management of fish, timber, water, wildlife, and other resources of the Oregon Coast Range. The COPE Program emphasizes an integrated approach—an integration of research and education and an integration of scientific disciplines—to find effective ways to manage these diverse resources collectively.

The COPE Program has two related components: Fundamental COPE and Adaptive COPE. Comprised of OSU and PNW scientists based primarily in Corvallis, Fundamental COPE addresses problems related to riparian zone management and reforestation in the Coast Range through basic research. Adaptive COPE is comprised of an interdisciplinary team responsible for applying and adapting new and existing research information to solve specific management problems. Stationed on the coast in Newport at the Hatfield Marine Science Center, the Adaptive COPE team is also resposible for providing continuing education opportunities to facilitate technology transfer.

ADAPTIVE COPE

ACTIVE MANAGEMENT TO ESTABLISH CONIFERS IN ALDER-DOMINATED RIPARIAN ZONES: Second-year results of conifer underplanting study

Introduction

Present forest cover in riparian areas of the Oregon Coast Range is dominated by red alder (*Alnus rubra*), a result of disturbance from logging, fire, and flooding. Few conifers have established in these areas because of the competition from overtopping alders and the understory shrubs. However, conifers play an integral part in the ability of the riparian ecosystem to function. Coarse woody debris results when mature trees die and fall over or are blown down by wind. In riparian area, this downed woody material often falls into the stream channel, affecting flows of water and nutrients, and fish habitat. Once they fall, conifers have a longer life than alder, which is more short-lived both as an upright tree and as a downed log. Thus, alder is more transient within the forest ecosystem. In order to provide a continuous source of conifer debris over time, conifers must be established within alder-dominated sites. Because of intense competition for light from the overstory and understory vegetation, manipulation of existing vegetation is often necessary. In 1989 a research project was initiated to determine the most successful methods for establishing conifer seedlings beneath a riparian alder overstory (*COPE Report* 2(3):4-5). This study will examine the growth of four species of conifers and the effectiveness of flexible tubing to protect seedlings from animal damage.

Methods

Six alder-dominated riparian sites in the Coast Range were selected for study. These sites were subjected to overstory and understory treatments, and seedlings of four conifer species were planted under the alder canopies. At each site, three overstory treatment plots (0.2 ha) were established (Figure 1). The treatments were an untreated control with no overstory removal, partial overstory removal (50 percent of existing canopy), and total overstory removal. This was accomplished by manual girdling or chemical hack and squirt techniques. Within each overstory plot, two understory subplots were established.

Understory treatments within these subplots were total understory removal and an untreated control (no understory removal). Methods used for understory manipulation were manual cutting or backpack spray with herbicides. Four conifer species (western redcedar, western hemlock, Douglas-fir, and grand fir) were underplanted at 2m X 2m spacing within each subplot. Every other seedling was protected with Vexar™ tubing against browsing by animals. Seedling height, diameter at the base, and diameter at 6 inches were

Block (site)

Overstory Treatment-Control

Overstory Treatment-Control	Overstory Treatment Total Removal
DF GF WH WRC	DF GF WH WRC

Overstory Treatment-Partial Removal

Understory Treatment-Control	Understory Treatment Total Removal
DF GF WH WRC	DF GF WH WRC

Overstory Treatment-Total Removal

Understory Treatment-Control	Understory Treatment Total Removal
DF GF WH WRC	DF GF WH WRC

Figure 1. Experimental design for underplanting study, showing the overstory, understory, and species treatments at each site (block). Underplanted conifers were DF=Douglas-fir, GF=grand fir, WH=western hemlock, WRC=western redcedar.

measured initially, and have been monitored at the end of every growing season. Seedling growth data have been analyzed with analysis of variance for a split-split-split plot design. First-year results have been reported in a previous issue of the COPE Report 4(2):2-4.

Results

Survival by species over all sites and treatments was highly variable. Survival of western redcedar was high on most sites relative to the other species; however, some decline in survival was seen by the end of the second year (Figure 2). With partial or no overstory removal, understory manipulation appeared to be a key factor in survival of all species except western redcedar. When the overstory is completely removed, survival of Douglas-fir improves further with understory manipulation.

Height growth increment for seedlings was significantly affected by location, overstory treatment, species, and tubing effects. Mean height growth was greater in both the total and partial overstory removal treatments than in the untreated control, but height growth in the total and partial overstory removal treatments were not different from each other. Mean height growth of western hemlock was significantly greater than all other species. Douglas-fir height growth was not different from grand fir, but was greater than western redcedar. Overall tubed seedlings had greater height growth than non-tubed seedlings.

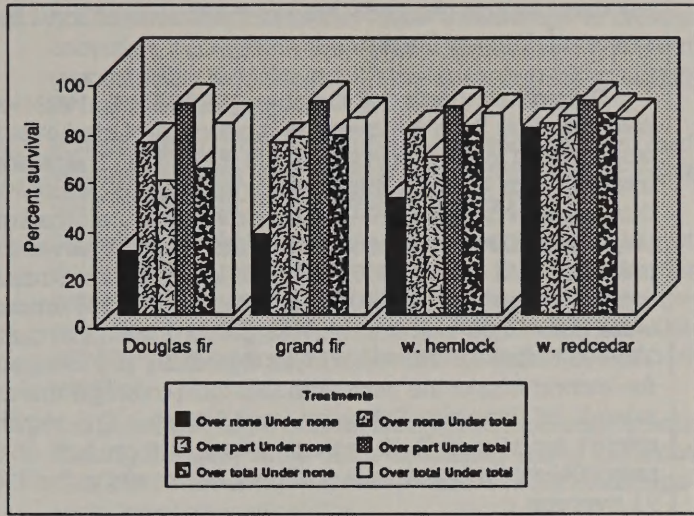


Figure 2. Survival of seedlings at the end of 2 years in all combinations of treatments. Treatments legend describes the combination of treatments as Over none Under none = Overstory removal none, Understory removal none, etc.

Summary

Total or partial manipulation resulted in greater seedling height growth. Western hemlock outperformed all other species over all treatments for height growth. Tubed seedlings grew taller than non-tubed seedlings.

Though the results of this experiment are preliminary, some early trends are identified. With partial or no overstory removal, understory manipulation is important to the survival of all species with the exception of western redcedar. With total overstory removal, understory manipulation appears important to Douglas-fir survival in particular.

Barbara Schrader, Gabe Tucker,
and Cathie Bacon (deceased),
Adaptive COPE

FUNDAMENTAL COPE

SUMMARY OF PRECIPITATION DATA FOR THE FIRST HALF OF THE 1992 WATER YEAR

This report summarizes data collected from OSU's 14-station rainfall monitoring network, located in the Mapleton and Alsea Ranger Districts of the Siuslaw National Forest and

the Coast Range Resource Area of the Bureau of Land Management, Eugene District.

Rainfall amounts for October 1991-March 1992 were markedly less than the average amounts recorded over the same period in the 3 previous years (Figure 1). The regional average was 48.65 inches, approximately 23 percent less than the average for 1989-91. These averages are based only on gauges one through nine. The remaining gauges were not installed until after 1989. For individual stations, rainfall amounts ranged from 38.01 to 65.40 inches. These amounts were from 18.60 percent to 27.88 percent less than during 1989-91 (Table 1). This deficit was especially pronounced in the second half of the year with less-than-average monthly rainfall for January, February, and March. The regional rainfall for March (2.45 inches) was less than half of the previous low for that month and only 20 percent of the 1989-91 average.

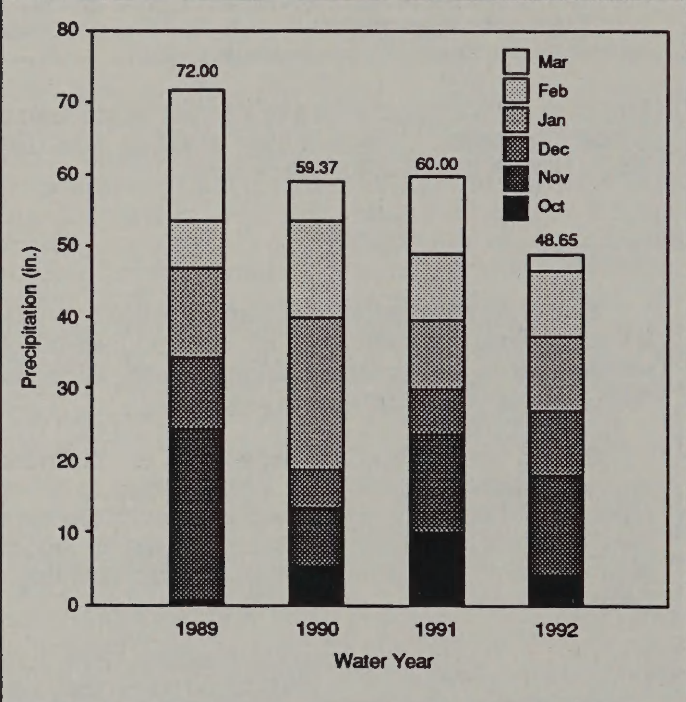


Figure 1. Comparison of winter precipitation, 1989 - 1992.

Precipitation began on October 16, breaking a 45-day dry period. The first substantial amount of rain, approximately 2-3 inches, occurred October 24-25. Precipitation events were mild (< 2 inches per 24 hrs) to moderate (2-5 inches per 24 hrs) and were interspersed with 6-10 day periods of little or no rain. After a moderate event at the end of January, only one other significant event (February 17-20) occurred during the rest of the winter.

Figure 1 illustrates a short-term "trend" of progressively drier winters that have occurred since 1989. The period of record is too short to identify a climatic trend. However, the observed decline in precipitation during the past several years indicates the potential for increased stress on forests, stream habitat, and water supplies through the summer of 1992.

Table 1. Monthly precipitation: October, 1991 - April, 1992.

Precipitation (inches)							Oct-Mar 91-92	Winter 89-91	
Gauge	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Total	Avg.	% Diff.
1	4.96	16.28	11.60	15.52	14.88	2.16	65.40	90.68	-27.88
2	4.12	13.76	10.20	10.36	9.08	2.08	49.60	68.49	-27.58
3	4.28	15.68	9.96	10.08	9.56	2.68	52.24	65.99	-20.84
4	5.88	16.84	11.87^{m}	12.26^{m}	11.52^{m}	3.00^{m}	61.37	80.95	-24.19
5	4.56	13.20	7.94^{m}	7.59^{m}	7.80^{m}	2.51^{m}	43.60	53.56	-18.60
6	4.36	13.84	8.68	8.16	8.80	3.00	46.84	58.87	-20.43
7	5.32	10.84	7.32	7.52^{e}	7.84^{m}	2.43^{m}	41.27	53.23	-22.47
8	3.32	11.20	7.96	6.72^{m}	6.93^{m}	1.88^{m}	38.01	47.88	-20.61
9	3.76	11.76	7.69^{m}	6.88	7.36	2.04	39.49	50.34	-21.55
11	4.00	14.16	10.08	11.88	11.40	2.36	53.88	N	
12	4.16	14.92	9.68	9.72	9.68	3.15^{e}	51.31	N	
14	3.08	11.56	7.48	11.68	9.00	2.40	45.20	N	
15	3.52	13.84	10.56	11.80	9.00	2.42^{m}	51.14	N	
16	2.56	13.32	8.68	12.24	9.40	2.20	48.40	N	
Avg.	4.13	13.66	9.26	10.17	9.45	2.45	49.13		
St.Dev.	0.85	1.80	1.46	2.48	1.98	0.37	7.49		
C.V.	0.21	0.13	0.16	0.24	0.21	0.15	0.15		

^{m} more than 1/3 of monthly amount estimated from other gauges.
^{e} 1/3 or less of monthly amount estimated from other gauges.
N station not in service over entire period.

Table 2. Precipitation amount and intensity for selected storms, October - March, 1992.

Date	Gauge	Total (in)	1 hr (in)	6 hr (in)	24 hr (in)	Antecedent 24 hr (in/hr)	Avg. Intens.
Nov.4-5	2	3.52	0.32	1.48	3.08	0.00	0.104
	3	4.16	0.52	2.24	4.04	0.20	0.149
	4	4.12	0.40	1.84	4.04	0.20	0.158
	5	2.84	0.32	1.36	2.76	0.16	0.110
	6	2.76	0.28	1.48	2.68	0.20	0.106
	7	1.72	0.28	0.80	1.64	0.08	0.066
	8	2.32	0.24	1.16	2.28	0.24	0.090
	9	1.68	0.24	0.88	1.68	0.16	0.073
	12	3.92	0.56	2.12	3.76	0.08	0.131
	15	3.24	0.32	1.52	2.72	0.00	0.080
	16	2.68	0.32	1.20	2.20	0.00	0.078
Nov. 19-20	1	3.72	0.56	2.04	3.72	0.36	0.155
	11	3.00	0.44	1.52	3.00	0.00	0.130
Dec. 5-6	1	5.96	0.44	1.32	4.56	0.44	0.192
	2	4.48	0.32	1.12	3.76	0.20	0.154
	3	3.96	0.32	1.32	3.88	0.24	0.152
	4	4.32	0.24	1.24	4.24	0.32	0.166
	6	3.28	0.28	1.04	3.16	0.20	0.122
	7	2.84	0.28	0.88	2.60	0.08	0.101
	8	3.04	0.16	0.64	2.96	0.12	0.113
	11	4.48	0.32	1.28	4.32	0.00	0.160
	12	3.40	0.24	0.96	3.28	0.32	0.126
	15	3.72	0.36	1.40	3.44	0.32	0.128
	16	3.36	0.28	1.00	3.08	0.24	0.108

(Table 2. continued)

Jan. 27-28	1	4.48	0.48	2.16	4.08	0.16	0.154
	11	3.08	0.36	1.44	2.92	0.20	0.118
	14	3.88	0.28	1.36	3.32	0.08	0.125
	15	2.76	0.32	1.08	2.76	0.16	0.115
	16	3.60	0.36	1.32	3.40	0.08	0.129
Feb. 17-20	1	10.48	0.48	1.72	4.24	0.32	0.131
	2	6.56	0.28	1.12	2.76	0.24	0.085
	3	6.24	0.32	0.96	2.84	0.40	0.081
	6	5.88	0.40	1.32	2.64	0.40	0.080
	9	4.28	0.24	1.16	2.64	0.48	0.081
	11	7.72	0.32	1.32	3.64	0.32	0.102
	12	6.52	0.44	1.28	3.20	0.44	0.084
	15	6.96	0.40	1.48	3.24	0.00	0.088
	16	6.76	0.40	1.52	3.04	0.08	0.082

Table 2 summarizes rainfall amounts and intensities for the three largest (and other) storms. The largest storm of the winter occurred on December 5-6. Total rainfall varied from 2.84 to 5.96 inches with maximum hourly intensities of 0.16 to 0.44 inches and maximum 24-hour intensities of 2.60 to 4.56 inches.

Kevin Lautz,
OSU Forest Engineering Department

AN INDEX OF CANOPY HEIGHT DIVERSITY

The structural diversity of vegetation is important in distinguishing stages of forest development and in the habitat selection of many animals, especially birds such as the northern spotted owl. However, layering (or diversity) is an often vaguely defined characteristic of forest stands. Several very labor-intensive techniques have been developed to measure the foliage height diversity of forest stands. These techniques include the use of vertical line intercepts with telephoto lenses and the estimation of the foliage cover of large checkerboard patterns at different heights and distances away from an observer. While these approaches may be useful for intensive analysis, they are not practical for large surveys and inventories. Another approach often used is to visually estimate the number of canopy layers in a forest. While this can be done relatively rapidly, it is subject to considerable observer bias and many forests do not sort out into discrete canopy layers. For general inventory purposes an index with the following properties is needed:

1. It should be easy to measure in the field and not be subject to observer bias.
2. It should be related to ecological function and be general enough to apply to a broad spectrum of ecological processes and organisms.
3. All other things equal, tall forests should have a higher index than short forests. Tall forests have thicker boundary layers and a greater range of microclimates and habitat structure than short forests. Tall trees influence more volume from top to ground than do short trees.
4. For forests of equal height, those with foliage or crowns occurring throughout the vertical space should have a greater index than those with foliage or crowns occurring at one or a few heights.
5. Forests with a greater volume of tree space (crown and volume beneath the crown) should have a higher index than forests with less volume of tree space.
6. The index should be capable of being scaled to the height potential of a particular forest type. For example, the index could be calculated differently for east-side lodgepole pine types than for west-side Douglas-fir types. This adjustment may or may not be desirable, but it should be possible.
7. The index should be at least partly predictable for remote sensing imagery since this is becoming one of the main methods of obtaining a first approximation of landscape-scale forest characteristics.

We have developed an index of canopy height diversity (CHD) that meets all of the above criteria. The CHD characterizes the height diversity and the volume of ecological space of trees in a stand. The ecological space of trees in a stand is defined as the sum of the imaginary cylinders surrounding individual trees with a cylinder height equal to the height of the tree and a cylinder diameter equal to the crown diameter of the tree (Figure 1). The CHD is calculated according to the following:

$$CHD = \sum_{i=i}^{N} P_i \,{}^*H_i \; i \qquad (1)$$

H_i is the relative height of height class i. The relative height of a height class is computed by dividing the upper limit of a height class by the upper limit of the lowest height class.

N is the number of height classes.

P_i is the height class-cover score of the ith height class based on the proportion of the ground area that is covered by the crowns of trees with that height class. It is calculated as:

$$P_i = \begin{cases} C_i/0.3 \text{ for } C< 0.3 \text{ (Threshold)} \\ \text{else } 1 \text{ for } C> = 0.3 \end{cases} \qquad (2)$$

where C_i is the horizontal crown area of a tree within height class i and is calculated as:

$$C_i = \frac{\sum_{i=1}^{K} A_j}{AG} \qquad (3)$$

where A_j is the horizontal crown area of the jth tree with the height class i and AG is the ground area of the sample, and k = the number of trees in height class i.

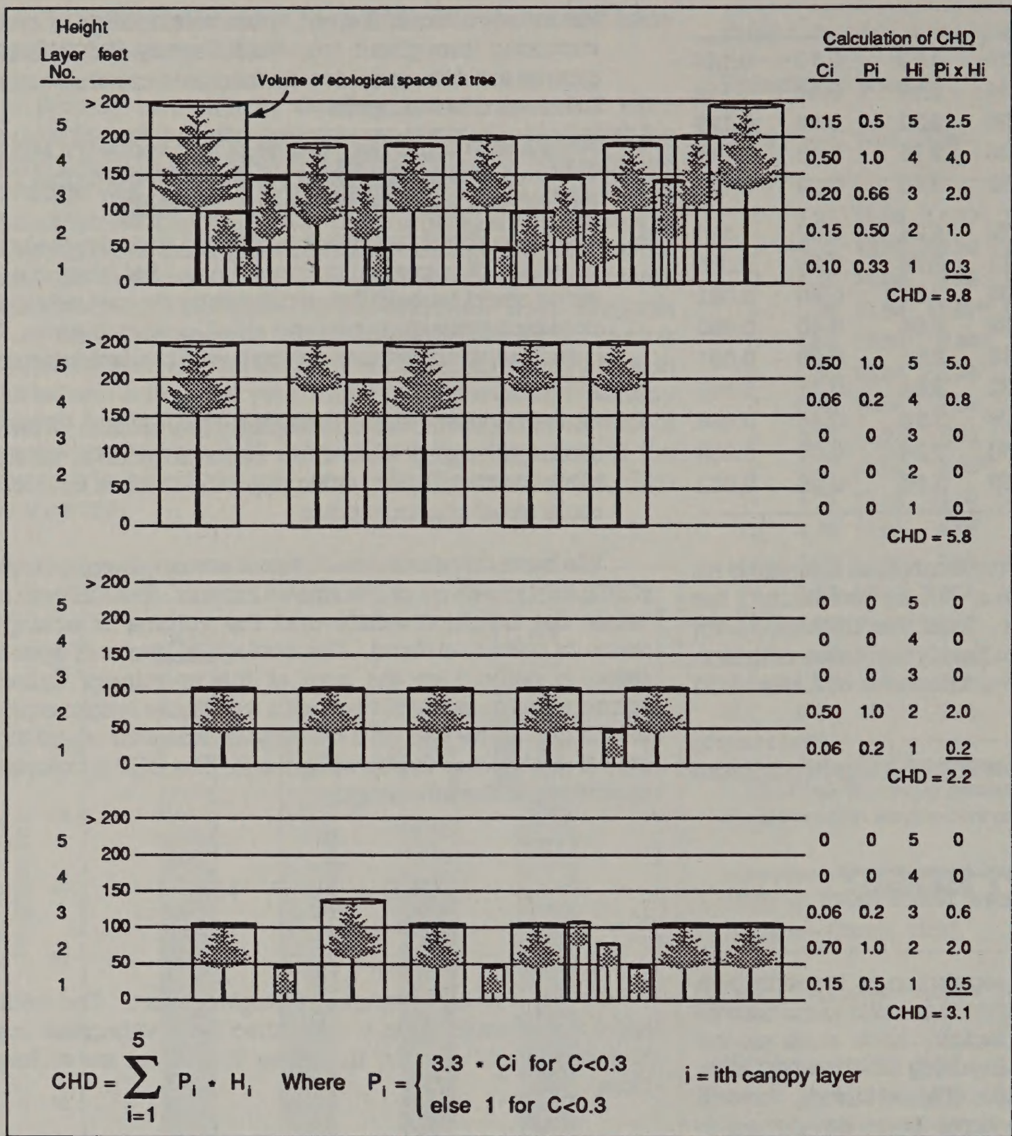


Figure 1. Examples of canopy height diversity calculations for stands with different structures.

The horizontal crown area of the tree (A_j) can be measured directly in the field or estimated from dbh data. The ground area proportion threshold (0.3 in equation 2 above) is the proportion of ground area covered by tree crown area at which the height class is considered to reach its full occupancy. The threshold can vary from <0.1 to 1.0. We determined the threshold empirically using the old-growth survey data set to examine how the relationship of the index to age changed as a function of different thresholds. We found that 0.3 seemed to produce a CHD that was most sensitive to differences in stand development in a chronosequence of sample stands ranging in age from 30 to over 900 years.

We have used height classes of 0-16m, 16-32m, 32-48m, 48-64m, and 64-80+m for west-side Douglas-fir stands. Smaller or more numerous height classes could be used with different forest types and objectives. Resolution for young stands may be limited. The relative heights of these five classes are 1,2,3,4, and 5. (Figure 1).

The maximal score for a stand is 15. In the old-growth data set, stands that were less than 100 years old had an average score of about 4 with a range from less than 1 in clearcuts to about 6 in some tall and complex young stands in the Coast Range. Stands 100 to 200 years old had an average score of about 7.5. The score was about 10 on dry or poorly stocked, low productivity sites, and ranged to over 14 on moist sites with tall emergent Douglas-firs and well-developed middle layers of western hemlock.

We tried other diversity indices, including Simpson's diversity index based on basal area in different height classes and tree density in different height classes, and found that they did not perform as well as CHD in characterizing structural development along a chronosequence. For example the correlation of the Simpson's diversity index based on basal area in a height class with stand age was 0.68 while the correlation of CHD with stand age was 0.85. While stand age is not necessarily the best criteria for comparing the value of different indices, for natural stands it is a good reflection of overall trend in stand development. We think the key to the index is basing it on crown diameter rather than basal area or tree density. The crown diameters are key elements for habitat structure, and the relationship between dbh and crown diameter is an asymptotic curve. Consequently, indices based on basal area give too much weight to trees with large dbh's whose crown diameters do not change much with increasing dbh. Interestingly, the standard deviation of tree dbh in a stand was highly correlated with stand age (r = 0.19) in a sample of 29 stands and can be predicted with the highest R^2 (0.82) of any stand attribute in the remote sensing regression models we have developed. Unfortunately, the standard deviation of dbh is not as easily linked to ecological process and habitat conditions as CHD, although it may be a good indicator of diverse stands.

CHD can be calculated from tree dbh measurements and a rough knowledge of dbh-height relationships and dbh-crown area relationships. CHD is based on the ecological assumption that a tree occupies a volume of ecological space and that this space consists of the crown, the bole, and the volume beneath the crown to the forest floor. This ecological space affects the habitat of canopy dwelling organisms, organisms using the tree bole, and organisms and processes affected by the cover microclimatic conditions underneath the crown of a tree. A tall forest would receive a higher score than a short forest because it has more habitat space and a

greater range of microclimates contained within it. Crown volume alone is often measured and associated with bird habitat. We have not used it in this index because: (1) we're not sure how well it can be estimated from dbh; (2) it is more time-consuming to measure in the field; (3) it does not reflect the entire volume of ecological space influenced by a tree; and (4) we think that measures of it would probably be correlated with ecological space volume.

The other apparent value of the CHD is that it is relatively predictable from satellite imagery (R^2 of .53 for SPOT imagery alone and an R^2 of 0.66 for a model combining SPOT and TM imagery). We have tested it for the central western Cascade Douglas-fir type only and would like to expand the model building to other locations and forest types.

At this time, we consider the CHD to still be in a state of development. We do not consider it a replacement for more detailed characterization of canopy diversity or a replacement for understory (shrub and herb layers) diversity measures which require ground-based sampling. We welcome suggestions and criticisms.

Tom Spies and Warren B. Cohen,
PNW Station, Corvallis

OF INTEREST

JUST WHEN CAN WE EXPECT RECOVERY? UPDATE ON THE NEW ALSEA WATERSHED STUDY (NAWS)

Introduction

Estimating the potential impact of a land use practice on the water resource requires information on background stream water quality and quantity. It also requires an understanding of the system response to a given set of controls. Without knowledge of these responses, a land use manager cannot hope to assess the magnitude or duration of potential impacts to water resources from land use activities.

The New Alsea Watershed Study (NAWS), now in its third year, addresses the concept of post-harvest recovery in forested ecosystems. This research is designed to provide a better understanding of long-term water quantity and water quality dynamics in managed coastal Oregon forests.

The Original Alsea Watershed Study

The original Alsea Watershed Study (AWS) (1959-1973) considered the effects of timber harvesting practices on hydrology, water quality, stream habitat, and fish populations. The original study utilized three small watersheds, Needle Branch (71 ha), Deer Creek (304 ha), and Flynn Creek (203 ha). These basins are tributary to Drift Creek. Stream gauging weirs were constructed in 1958-1959, and monitoring began in 1959. Roads were constructed on Needle Branch and Deer Creek in 1965. Logging took place from March through October 1966. Post-treatment monitoring continued until the fall of 1973. Needle Branch was completely clearcut, with no vegetative buffer strip or other stream protection. Deer Creek was treated with three clearcuts of about 25 ha each, with a vegetative buffer strip left along stream channels. Flynn Creek was left undisturbed and served as the untreated control watershed for assessment of treatment effects in Deer Creek and Needle Branch.

The AWS had 7 years pre-treatment data, 1 year for treatment (timber harvesting) and 7 years of post-treatment data. Departures from the pre-treatment regressions between the control watershed (Flynn Creek) and the treatment watersheds were used to assess treatment effects. Study results were used to develop state forest practices legislation and are still utilized by teachers and researchers. Several publications document study results (see suggested readings): a summary, a retrospective by the original principal investigators, and a compilation of AWS and more recent Alsea research.

The New Alsea Watershed Study

No efforts outside the original study were made in the Alsea area until 1989. Reactivation of the Alsea water resources monitoring program provides a unique opportunity to assess the hydrologic recovery and long-term effects of silvicultural treatments on water and water-related resources. Currently, the water resources monitoring program is independent of biological monitoring, but a salmonid inventory was recently completed.

Flynn Creek is now designated a Long-term Research Natural Area by the USDA Forest Service to be used to characterize undisturbed coastal Oregon ecosystems. Forest regeneration on Needle Branch has been unmanaged except for some precommercial thinning in 1981. This forest thinning is not considered to affect water resources or the fishery resources.

Deer Creek had a second timber harvesting entry of 20 ha in 1978, and two units totalling approximately 22 ha were logged in 1987 and 1988. The multiple entries in Deer Creek provide the opportunity to assess our ability to predict hydrologic recovery and to identify potential cumulative watershed effects.

Some of the questions addressed by our research include:

1. Has the annual water yield from Needle Branch returned to pre-treatment levels 26 years after harvest?
2. What is the long-term effect of timber harvesting on peakflows?
3. What is the long-term effect of timber harvesting on summer lowflows?

4. What is the long-term effect of timber harvesting on water quality?

Annual Water Yield

The 1990 and 1991 annual water yields for Flynn Creek were 1677 and 1649 mm, respectively (Table 1). Water yields for Needle Branch for the same years were 1761 and 1899 mm. These yields are 149 and 313 mm greater than the yields predicted by the pre-treatment regression. The annual water yield difference for 1990 was within the pre-treatment prediction equation confidence limits, while the 1991 water yield difference is outside these same confidence limits. Needle Branch does not demonstrate hydrologic recovery as measured by annual water yield, given the original prediction equations. The 1990 and 1991 annual water yields for Deer Creek were 1705 and 1753 mm, or 101 and 178 mm greater than predicted by the Flynn Creek data. These water yields are within the confidence limits established by the pre-treatment regression.

Table 1. Annual water yield (in mm) New Alsea Watershed Study.

	Flynn Creek	Needle Branch		Deer Creek	
Year	Actual	Actual	Predicted	Actual	Predicted
1990	1677	1761	1612	1705	1604
1991	1649	1899	1586	1753	1575

The role of climate in hydrologic recovery (the return to pre-treatment yields) cannot be ignored. For the post- treatment data, the 3 wettest years (1969, 1971, and 1972) had a mean annual precipitation of 3216 mm. The mean difference between the observed and predicted annual water yields from Needle Branch was 618 mm. Conversely, the 3 driest years (1973, 1990, and 1991) had a mean annual precipitation of 2050 mm and a mean yield difference of 241 mm. Differences in annual water yield are significantly correlated to annual on-site precipitation and not significantly correlated to time since harvest. Annual water yields from Deer Creek fit the new hydrologic recovery model.

Peakflows

The AWS selection criterion for peakflows (approximately bank-full discharge) was 0.55 $m^3/sec/km^2$ (50 cu. ft. per sec. per sq. mi.). For water year 1990, three events exceeded the selection criterion. The observed peakflows were outside the original 95 percent confidence bounds for Needle Branch, but within the range observed during the AWS post-treatment monitoring, as were the storms for Deer Creek. There was only one storm in 1991 above the selection criterion. Peakflows for Needle Branch and Deer Creek were both approximately 8 percent greater than predicted, but within the error limits of the prediction equation. No storm events exceeded the selection criterion in 1992.

The long-term effect of harvesting on peakflows is unclear. Since the watersheds have only had four significant storms in 3 years, and since the integrity of the control watershed is in question (see below), more work on peakflows is required.

Lowflows

Unexpectedly, summer lowflows in Needle Branch were the lowest on record. Since our streamflow record collection and reduction is more accurate and precise than the original AWS records, data compatibility is an issue to be addressed. Still, we found the measured lowflows in Needle Branch significantly less than predicted by the Flynn Creek data. Annual precipitation was 2063 mm in 1990 and 2150 mm in 1991, or 81 and 85 percent of the post-treatment mean (3216). The influence of drought on lowflows is not well understood in the Oregon Coast Range.

Although Flynn Creek is undisturbed by management activities, it has recently been affected by beaver activity. The effects of beaver activity on channel morphology, channel delivery efficiency, flood wave attenuation, and increased source area for streamflow generation has compromised the integrity of Flynn Creek as an untreated control treatment from which to assess treatment responses. No beaver activity was noted in Flynn Creek in the AWS study. Flow duration curves for Flynn Creek (probability of a given flow to be exceeded) have shifted since the original AWS. Beaver dams appear to attenuate peakflows, and to augment lowflows.

Mill Creek, an undisturbed watershed north of the area, is being monitored as a second untreated control to better assess the suitability of Flynn Creek as a control. This watershed has a northern exposure and is larger than the original three watersheds, but is otherwise comparable in physiography, soils, and vegetation.

Water Quality

Traditionally, water quality studies measure chemical constituent concentrations in surface waters as they relate to water quality standards or criteria. While concentrations may quickly return to pre-treatment levels after treatment, continued increased water yields may increase nutrient export and potentially affect site productivity. With increased water yields, it is essential to use chemical flux rates or nutrient export rates to determine long-term effects of silviculture on forest sustainability.

Water quality data for water years 1990 and 1991 show chemical variability within and between the watersheds. Water chemistries are generally comparable except for nitrate-nitrogen. The nitrate-nitrogen output from Flynn Creek is approximately 3 times greater than the same flux from Needle Branch (Table 2). Nitrate-nitrogen losses from Deer Creek were lower than, but comparable to, Flynn Creek.

The large nitrate-nitrogen export from Flynn Creek could potentially affect forest productivity. A subbasin water quality sampling program was initiated in 1990 to identify the processes controlling surface water quality, particularly nitrate-nitrogen. Five to seven homogeneous subbasins are sampled in each watershed for soil and water chemical

Table 2. Nitrate-nitrogen fluxes (kg/ha/yr) for each watershed.

Year	Flynn Creek	Needle Branch	Deer Creek
1965	35	3	21
1966	27	5	25
1967	28	16	28
1968	25	15	25
1990	20	7	15
1991	26	9	19

analyses. Subbasin characteristics, or landscape elements, are used to identify streamflow generation mechanisms and subsequent streamflow routing. Water residence time and origin will be determined by chemical and isotopic analyses. Nitrate-nitrogen concentrations are not affected by beaver activity. Instead, vegetation influences, particularly red alder *(Alnus rubra)*, appear to be important as they relate to soil water routing. Areal distribution of vegetation plays a less significant role.

Orthophosphate concentrations were always below analytical detection limits (0.10 mg/L) and provide no insight to long-term effects of timber harvesting on phosphorus dynamics.

Summary

The NAWS is an important addition to the long-term hydrologic data base and provides the opportunity to assess potential hydrologic and water quality cumulative impacts from multiple harvest entries in the Oregon Coast Range.

One can assess land use activities and their potential environmental impact by monitoring changes in water resources. Perhaps the easiest to measure, and certainly the most documented, are the effects of land use on water yield. Streamflows from the small Alsea watersheds will better reflect soil-vegetation-water interactions, and chemical differences in water quality are more apt to be seen before downstream dilution. Continuation of the Alsea water resources monitoring network will identify potential long-term effects on soil and water resources from silvicultural activities.

Once the mechanisms of hydrologic recovery and cumulative watershed effects are understood, these processes will be modeled by a Geographic Information System (GIS). This model will help predict land use effects in time and space. This future research will be based on the processes observed in small watersheds, but will be extrapolated to basin level planning.

Suggested Readings

Hall, J.D., G.W. Brown, and R.L. Lantz, 1987. The Alsea Watershed Study: In retrospective. P. 399-416 in Streamside Management: Forestry and Fishery Interactions. E.O. Salo and T.W. Cundy, eds. Institute of Forest Resources, University of Washington, Seattle. Contribution 57.

Ice, G.G., and J.D. Stednick, Editors. 1991. The New Alsea Watershed Study. National Council for Air and Stream Improvement, New York. Technical Report 602. 93 p.

Moring, J.R., and R.L. Lantz, 1975. The Alsea WatershedStudy: Effects of logging on the aquatic resources of three headwater streams of the Alsea River, Oregon. Oregon Department of Fish and Wildlife, Corvallis. Fishery Research Report 9. (3 volumes).

Acknowledgements

The authors wish to acknowledge the support of Dr. George Ice of the National Council of the Pulp and Paper Industry for Air and Stream Improvement, Inc. (NCASI) and Dr. Jim Hall, Dr. Bill Atkinson, Dr. Hank Froehlich, Dr. Paul Adams, Mr. Jim Kiser, and Mr. Arne Skaugset of Oregon State University.

John D. Stednick and Tim J. Kern,
Colorado State University

PRELIMINARY COPE REPORT SURVEY RESULTS

The last issue of the COPE Report (5:1&2, insert) offered a reader survey. To date, the results are as follows:

Question number	Poor (0-20%)	Fair (21-40%)	Satisfactory (41-60%)	Good (61-80%)	Excellent (81-100%)
1	00	02	12	55	31
2	01	04	19	52	24
3	05	23	34	35	03
4	01	08	25	52	14
5	13	18	35	31	03

Questions were:

1. How do you rate the technical quality of the COPE Report articles?
2. What is your opinion of the mix of disciplines offered? (i.e., fisheries/wildlife/silviculture/hydrology/soils)
3. What percentage of the information presented is useful?
4. How do you rank the use of illustrations and tables?
5. How do you rank the importance of photographs in the newsletter?

(Results are reported as a percent of the total number of respondents.)

The majority of the respondents were satisfied or enthusiastically supportive of the current format/subject matter of

the COPE Report. We will attempt to incorporate suggestions from readers where applicable.

We apologize for any inconvenience anyone might have experienced with surveys returned for postage. Unfortunately, the wrong mailing permit was printed for return postage. The bulk of those received, were accepted through the postal service, but we realize that some were not.

OPPORTUNITIES

FOREST SOILS AND RIPARIAN ZONE MANAGEMENT: THE CONTRIBUTIONS OF DR. HENRY A. FROEHLICH TO FORESTRY, 1970 TO 1992.

November 17, 1992 La Sells Stewart Center Corvallis, OR

A one-day symposium will be held at the LaSells Stewart Center to honor Dr. Henry Froehlich for his contributions to forestry and forest hydrology research during his 22 years with the Department of Forest Engineering at Oregon State University. Dr. George Brown, Dean of the College of Forestry, will give the keynote address. This will be followed by presentations on soil compaction, general hydrology and slope stability, woody debris in streams, and riparian zone management.

The symposium will include a catered lunch at the Valley Football Complex. Dr. William Atkinson, head of the Forest Engineering Department will be the lunch-time speaker. Please reserve the day now if you plan to attend. For more information, contact the Conference Assistant, College of Forestry, Oregon State University, 202 Peavy Hall, Corvallis, OR 97331-5707, or phone (503) 737-2329.

COMPUTER AIDED ROAD DESIGN

December 8-10, 1992 OSU

This three day course is offered by the Forest Engineering Department to practicing forest road designers who are interested in learning the principles of computer-aided, low-volume forest road design. Participants will have the opportunity to input a sample road survey data set, design a road, and output design quantities and plots using up-to-date Autocad software.

For more information, contact the Conference Assistant, College of Forestry, Oregon State University, 202 Peavy Hall, Corvallis, OR 97331-5707, or phone (503) 737-2329.

SILVICULTURE INSTITUTE: MODULE 3— STATISTICS AND FOREST MENSURATION

January 11-22, 1993 Seattle, WA

The Silviculture Institute is composed of six modules which take place over a year's period. Instruction is shared equally between Oregon State University and the University of Washington. Each module focuses on a single broad topic with detailed applications. The program is intensive and carries graduate credit. Persons interested in individual modules or the entire series are encouraged to apply.

The participants apply the principles of statistics in gaining knowledge of concepts critical to interpretation of stand management data and the results of pertinent biological and economic research. Modeling techniques and objectives are described, and various stand management models are introduced for analyzing forestry problems.

For more information, contact the Conference Assistant, College of Forestry, Oregon State University, 202 Peavy Hall, Corvallis, OR 97331-5707, or phone (503) 737-2329.

COPE: A REGIONAL ASSESSMENT OF STREAM HABITAT INVENTORY AND MONITORING PROGRAMS

January 26-28, 1993 OSU

Stream habitat inventories and associated monitoring programs are a primary infomation source for management decisions regarding aquatic resources. The intent of this symposium is to: review underlying principles of inventory methodology and design; provide technical information on data mangement and analysis; and examine current and potential applications utilizing inventory and monitoring information. Program information will be useful for both resource managers and resource biologists, and applicable to rural or urban settings.

For more information, contact the Conference Assistant, College of Forestry, Oregon State University, 202 Peavy Hall, Corvallis, OR 97331-5707, or phone (503) 737-2329.

WESTERN FORESTRY & CONSERVATION ASSOCIATION ANNUAL MEETING

December 7-9, 1992 Red Lion Jantzen Beach, Portland, OR

Theme: Balancing Technology and Politics in the Practice of Forestry.

For more information contact Richard Zabel (503) 226-4562.

RECENT PUBLICATIONS

REFORESTATION PRACTICES IN SOUTHWESTERN OREGON AND NORTHERN CALIFORNIA edited by Stephen D. Hobbs, Steven D. Tesch, Peyton W. Owston, Ronald E. Stewart, John C. Tappeiner II, and Gail E. Wells. 1992. Forest Research Laboratory, Oregon State University, Corvallis. 465 pages.

Just published by the Forest Research Laboratory at Oregon State University, this 465-page hardcover book is a comprehensive synthesis of reforestation-related research results developed by the Forestry Intensified Research (FIR) Program and other research organizations. Although the book is focused on the forests of southwestern Oregon and northern California, the principles, procedures, and practices discussed have broad applicability. It is the only comprehensive reforestation text to be produced in Oregon since *Regenerating Oregon's Forests* was published in 1978.

Thirty-eight authors have written 17 chapters which are organized into five sections. The first section, Planning and Historical Perspectives, contains two chapters that provide an overview of the reforestation planning process, including the critical elements, examples of reforestation prescriptions, and a history of the development of the region's resources. The second section covers the region's ecology and has five chapters that span everything from geology and climate to vegetation and ecophysiology. The third and largest section is Regeneration Operations. Seven chapters are included in this section: Regeneration Methods, Harvesting, Site Preparation, Natural Regeneration, Genetics, Stocktype Selection, and Planting. Chapters on surveys and evaluations, and protecting seedlings represent the fourth section on Post-Planting Operations. The fifth and final section has a single chapter which provides perspectives for mid- and upper-level managers.

The book contains numerous tables, photographs, and illustrations. It also contains a glossary of terms, a list of common and scientific names, a table of metric and English conversion factors, and a detailed subject index. References are listed at the end of each chapter.

Reforestation Practices in Southwestern Oregon and Northern California is available for $27.00 and can be ordered by contacting the Forestry Business Office, College of Forestry, Oregon State University, Corvallis OR 97331.

SDH

NORTHERN SPOTTED OWLS: INFLUENCE OF PREY BASE AND LANDSCAPE CHARACTER by A.B. Carey, S.P. Horton, and B.L. Biswell. 1992. Ecological Monographs 62(2):223-250. This paper reports the results of an intensive evaluation of characteristics of home range of spotted owls. The home ranges of several pairs of owls in southwestern Oregon were determined by radiotelemetry. The relationship between home range size and several habitat variables, including prey biomass, stand seral stage, tree species composition, landscape pattern indices, and percent of old forest, was examined. In heavily fragmented habitat, owls traversed 85 percent more area in Douglas-fir forests and three times more area in mixed conifer forests than they did in less fragmented habitats. In contrast to home ranges of owls in less fragmented habitats, those of owl pairs in heavily fragmented areas showed increased overlap with other pairs of owls, and owls in heavily fragmented areas exhibited an abnormal social structure. Of the 47 owls tracked by radiotelemetry, 46 selected old forests and one selected younger forests for foraging and roosting. Flying squirrels, the principal prey species of spotted owls, were most abundant in old forests. The authors hypothesize that patterns of habitat utilization and the selection of old forests by spotted owls are related to differences in abundance of the prey base and that regional variation in home range size of spotted owls is a result of differences in flying squirrel densities and the amount of habitat fragmentation.

JPH

STREAMSIDE VERSUS UPSLOPE BREEDING BIRD COMMUNITIES IN THE CENTRAL OREGON COAST RANGE by K. McGarigal and W.C. McComb. 1992. Journal of Wildlife Management 56(1):10-23. Although the importance of riparian zones for a number of water-dependent wildlife species is well documented, the importance of riparian zones for many terrestrial vertebrates is poorly studied. In this study, funded by COPE, McGarigal and McComb examined the importance of riparian zones to breeding bird populations along second- and third-order streams in the Oregon Coast Range. Bird community structure and composition differed between streamside and upslope areas. Thirty-three percent of the bird species seen were found exclusively in upslope areas, while only 9 percent of the species were seen only in streamside areas. Of the species that were detected more than 30 times, only the winter wren and Swainson's thrush were more abundant along streamsides than in upslope areas, whereas five species were more abundant upslope. The authors conclude that management of riparian areas alone is inadequate to provide sufficient habitat for many breeding birds in the Coast Range. The authors advise caution in widespread application of their findings, noting that the scope of the study was limited to diurnal bird populations along second- and third-order streams in the Drift Creek basin and that the results from studies of younger, managed forest stands may differ.

JPH

SILVICULTURAL APPROACHES TO ANIMAL DAMAGE MANAGEMENT IN PACIFIC NORTHWEST FORESTS by Hugh C. Black, technical editor. 1992. USDA Forest Service General Technical Report PNW-GTR-287. 422 p. Individual copies of this publication can be ordered by contacting U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, P.O. Box 3890, Portland, OR 97208; Publication requests (503) 326-

7128. (This publication also includes a PC DOS Compatible diskette with a habitat occupancy model demonstration by W.C. McComb entitled "The Boomer Advisor.")

This book examines the potential of silvicultural approaches for managing animal damage in forests at two levels: management of free-to-grow stands and site-specific practices that foster prompt and successful regeneration. Introductory chapters provide a historical perspective of animal damage management in the Pacific Northwest; describe the elements of an integrated approach to forest protection; review the principles of vegetation and wildlife management; and examine the influence of silvicultural practices on habitat and animal damage. Individual chapters are devoted to the ecology and control measures appropriate to species of wildlife and livestock that damage forest stands. Coverage includes the influence of silvicultural practices on habitat, populations, and damage.

The book focuses on the potential of silvicultural practices to limit animal damage, but it also includes information on chemical repellents, mechanical barriers, and direct control measures. Other chapters deal with the development of integrated silvicultural prescriptions, including modeling systems to limit animal damage. A concluding chapter discusses social, political, legal, and ethical aspects of animal damage.

ERRATUM

In the last issue of the COPE Report 5(1&2):12-13, "Climbing Trees to Look for Maple Seedlings," Scott Ketchum and John Tappeiner of Oregon State University, Forest Resources Department, should have been listed as second and third authors respectively. We apologize for the unintentional omission.

COPE

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COPE Report

Coastal Oregon Productivity Enhancement Program

Promoting Integrated Management of Oregon's Coast Range Forests
Through Research and Education

Volume 5, Number 4 Fall 1992

From the Program Manager

In this issue of the COPE Report we have featured two studies that focus on riparian areas. The first is an adaptive silviculture study led by Gabe Tucker that explores the release potential of four coniferous species in six red alder-dominated riparian areas. The second study, led by Bill McComb, examines bird species in riparian and adjacent upslope areas along second- and third-order streams. These are just several of the many studies COPE has underway that are focused on riparian-related resources.

The reason we have devoted much of our energy toward riparian research is because these areas are so important to many of the natural resources Oregonians value and because prior to COPE, we knew relatively little about them. Thirty-one COPE studies (57 percent of the total) are related to riparian resources. Scientists are making tremendous strides in our understanding of fish and wildlife communities, their habitat requirements, the dynamics of riparian vegetation, landslides, and riparian silviculture. Moreover, scientists like Joe Means, Tom Spies, Bill McComb, Gordon Reeves, and their colleagues have started to examine riparian and upslope areas from a landscape perspective as part of the "Coastal Landscape Analysis and Modeling" study. Additionally, work by other scientists looks at the dynamics of buffer strip vegetation along streams, and the role it plays in fish and wildlife habitat. The amount of new information that is being developed is impressive.

The research that Forest Service and OSU scientists are conducting in the Oregon Coast Range will significantly contribute to how riparian and adjacent upslope sites are managed in the future. The information that they provide will lead to decisions that are based on a better understanding of these ecosystems, their components, and how they respond to different management practices.

Steve Hobbs

Steve Hobbs

IN THIS ISSUE

The COPE Report is produced quarterly by the Adaptive COPE Team. Because of space limitations, articles appear as extended abstracts. Results and conclusions may be based on preliminary data and/or analysis. Readers interested in learning more about a study should contact the principal investigator or wait for formal publication of more complete results. Comments and suggestions concerning the content of the COPE Report are welcomed and encouraged. To receive this free newsletter, contact Adaptive COPE, 2030 S. Marine Science Dr., Newport, OR 97365, (503) 867-0220. For specifics on the overall COPE Program, contact Steve Hobbs, COPE Program Manager, Forestry Sciences Laboratory, 3200 SW Jefferson Way, Corvallis, OR 97331, (503) 750-7426.

The COPE Program is a cooperative effort between Oregon State University's College of Forestry, the USDA Forest Service, Pacific Northwest Research Station, the USDI Bureau of Land Management, other federal and state agencies, forest industry, county governments, and the Oregon Small Woodland Association. The intent of the program is to provide resource managers and the public with information relative to the issues and opportunities associated with the management of fish, timber, water, wildlife, and other resources of the Oregon Coast Range. The COPE Program emphasizes an integrated approach—an integration of research and education and an integration of scientific disciplines—to find effective ways to manage these diverse resources collectively.

The COPE Program has two related components: Fundamental COPE and Adaptive COPE. Comprised of OSU and PNW scientists based primarily in Corvallis, Fundamental COPE addresses problems related to riparian zone management and reforestation in the Coast Range through basic research. Adaptive COPE is comprised of an interdisciplinary team responsible for applying and adapting new and existing research information to solve specific management problems. Stationed on the coast in Newport at the Hatfield Marine Science Center, the Adaptive COPE team is also resposible for providing continuing education opportunities to facilitate technology transfer.

ADAPTIVE COPE

ACTIVE MANAGEMENT OF RIPARIAN ZONES FOR MULTIPLE RESOURCES: Second year results of conifer release study.

Introduction

Riparian areas in the Oregon Coast Range are often dominated by red alder following disturbance from past logging, fires, or floods. Many of these streams are also debris-poor as a result of historic logging practices (e.g., splash-damming, stream cleaning). Recruitment of down logs to streams is a priority for riparian zone managers because large woody debris has been shown to be an important component of the stream ecosystem, particularly for improving fish habitat. For example, large woody debris can create quiet refuges for salmonids during high flow events. Red alders will not provide large, persistent woody debris to streams because they are relatively small and rot quickly. Conifers, however, are the principal source of large woody debris to streams. Scattered conifers are often still present in riparian areas, but remain suppressed by overtopping alders. Release of these conifers from alder suppression could allow conifers to dominate a site more rapidly, eventually providing, among other benefits, large woody debris needed for fish habitat. In 1990 a research project was initiated to determine the tree and stand conditions associated with successful release of understory conifers in alder-

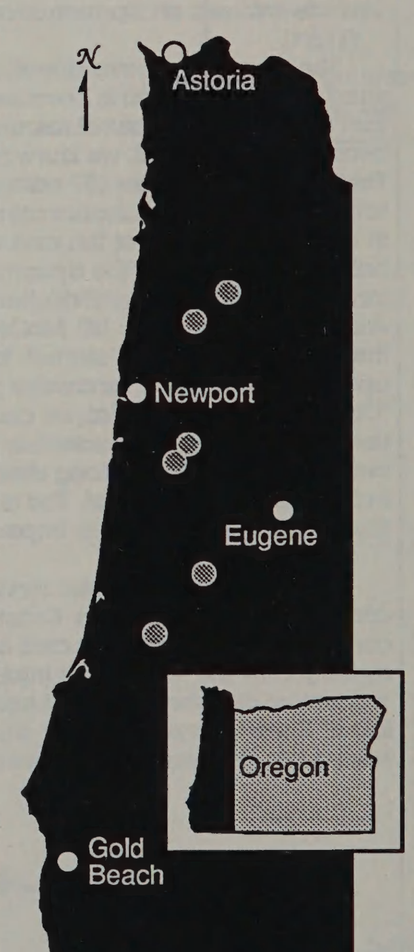

Figure 1. Adaptive COPE riparian silviculture research conifer release study site (●).

dominated riparian zones in the Oregon Coast Range (COPE Report 2(4):2-4).

Methods

We selected six streams in the Oregon Coast Range with alder-dominated riparian zones containing suppressed understory conifers (Figure 1). At each site, approximately 50 trees were selected for treatment. Tree species studied were Sitka spruce, western hemlock, western red cedar, and Douglas-fir (Figure 2). We chose study trees with initial heights of 1 to 20 meters (Figure 3). Each tree received one of the following overstory treatments: (A) complete removal of the red alder overstory by felling, (B) girdling of all overstory trees by manual cutting with an axe, and (C) an untreated control treatment with no manipulation of the overstory. Both the girdling and the felling were performed in a radius equal to a quarter of the total canopy height of the stand. Three sites were treated in 1990, and three more in 1991 (see Table 1). Study tree diameter at breast height (dbh), total height, and height to base of live crown were measured initially and following each subsequent growing season.

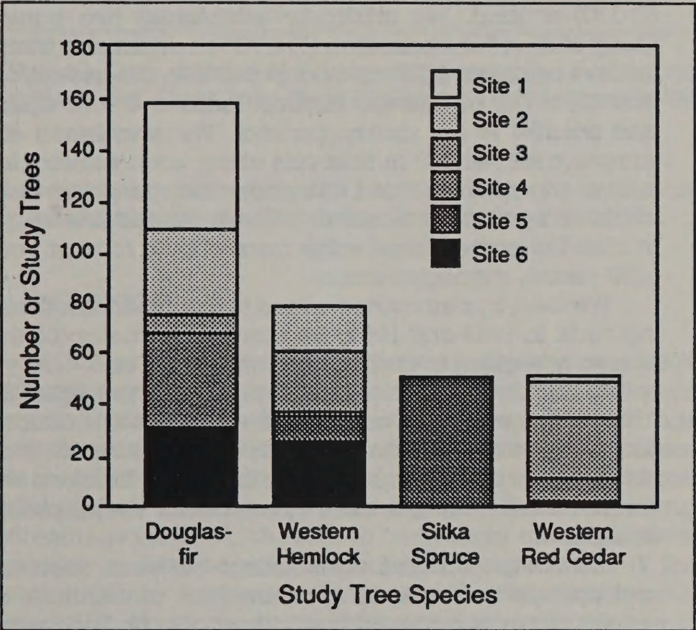

Figure 2. Release study trees by species and site.

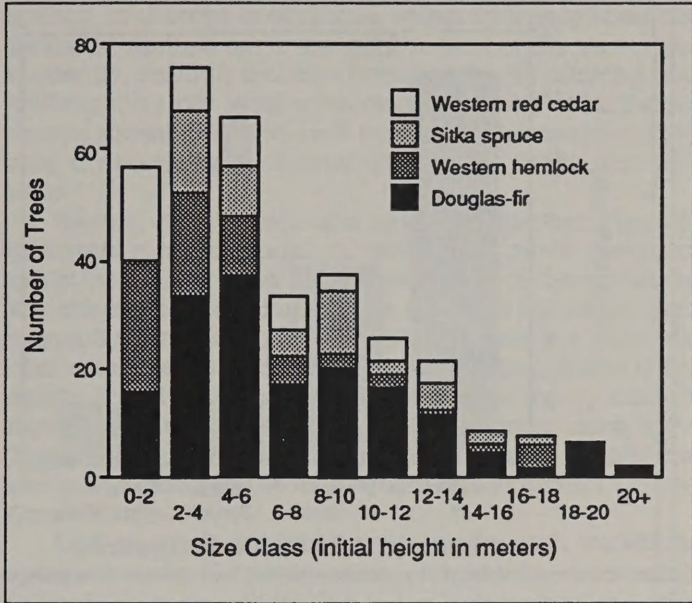

Figure 3. Release study trees by size class and species.

Results

The tree height and dbh data are still too preliminary for analysis; we expect that after three growing seasons analysis will be possible. However, mortality data are available (Figure 4). These data indicate, not surprisingly, that the relatively shade intolerant species (Douglas-fir) has a higher mortality rate than the shade tolerant species. All Douglas-fir that died succumbed to the effects of competition and reduced light. Rodents (mountain beavers and beavers) were a source of mortality for the shade tolerant species (Figure 4).

Table 1. Riparian conifer release project study sites.

Site	Name	Nearest town	Ownership	Location	Date treated
1	Nestucca R.	Beaver	Willamette Industries	T3S R62 SEC 8	1991
2	Squaw Cr.	Cloverdale	Simpson Timber Co, USFS, Hebo R.D.	T5S R10W SEC 22 T5S R10W SEC 27	1990
3	Tobe Cr.	Alsea	B.L.M.	T14S R7W SEC 19	1990
4	J-Line Cr.	Alsea	B.L.M.	T15S R8W SEC 22 T15S R8W SEC 27	1991
5	Halfway Cr.	Elkton	B.L.M.	T21S R8W SEC 1 T21S R8W SEC 12 T21S R8W SEC 7	1990
6	Fall Cr.	Coos Bay	Weyerhaeuser Co.	T5S R9W SEC 30 T5W R9W SEC 20 T5S R9W SEC 21	1991

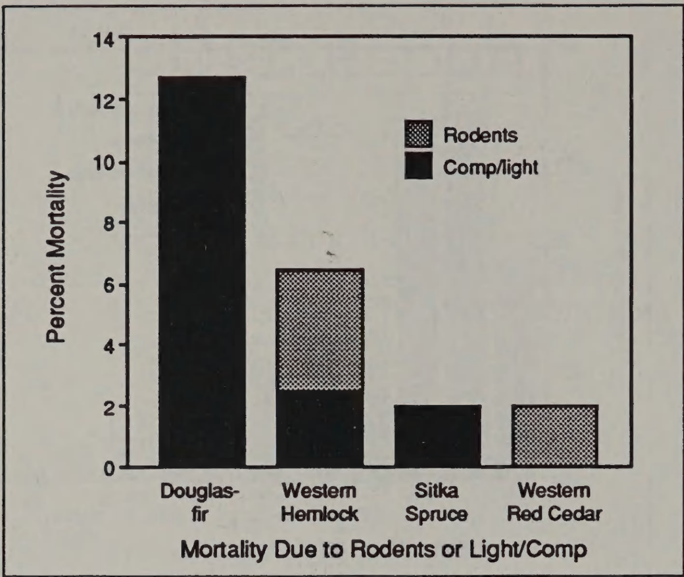

Figure 4. Percent mortality to date of release study trees by species and mortality cause.

The strategy of girdling alders to release understory conifers has both advantages and drawbacks. The advantages include a slower release than felling, with several years of partial alder-leaf-covered dead shade. This allows the suppressed conifers more time to adjust to the increase in light, thus potentially decreasing the "thinning shock" effect. A drawback of girdling is that standing dead alders can often fall as a whole tree, potentially pinning understory conifers. Some girdled alders were weakened and snapped at the girdle point. They fell unguided and came close to crushing study trees. However, many of the alders may gradually break apart with less risk of pinning conifers.

Eric Horvath and Gabe Tucker,
Adaptive COPE

FUNDAMENTAL COPE

STREAMSIDE VERSUS UPSLOPE ASSOCIATIONS OF BREEDING BIRDS

Several authors have found that riparian areas generally support a greater number of vertebrate species and greater abundances of many other species than adjacent uplands. These results have stemmed largely from studies in relatively arid environments where transriparian gradients in microclimate and vegetation are pronounced. It is unclear whether these results apply to moist coniferous forests in western Oregon where transriparian gradients are less dramatic. We investigated the value of second- and third-order streamside areas to vertebrates in mature, unmanaged forest stands in the central Oregon Coast Range. Here we review our findings for diurnal breeding birds. The results of studies examining riparian zone utilization by small mammals and amphibians will be reported in a future *COPE Report* article. We have published a more detailed description of the methods and results of our bird study elsewhere (see suggested readings).

Study Area

We selected six second- and third-order streams in large (>60 ha), mature, unmanaged forest stands distributed throughout Drift Creek Basin, Lincoln County. Bank-full streams averaged 2.8 m wide (Standard error = 0.4, range 2.0-5.0) and drained an average of 197 ha (SE = 34, range 82-330) of land. We arbitrarily established two transects along each of the six streams: (1) a 700-m streamside transect located adjacent ($\leq$20 m) and parallel to the stream axis, and (2) a 700-m upslope transect located 400 m upslope and parallel to the stream transect. We established eight sample points at 100-m intervals along each transect for a total of 48 streamside and 48 upslope sample points distributed evenly over the six stands. All sample points were $\geq$100 m from the nearest forest edge created by a road or young ($\leq$30 years), managed stand.

We used a point count method to sample diurnal breeding birds. In 1988 and 1989, we sampled each stand 6 times at nearly regular intervals between 1 May and 4 July for a total of 12 visits per sample point. Surveys began 0-20 minutes before sunrise and ended within 4 hours after sunrise. Our goal was to accurately estimate relative bird abundances at the transect level; therefore, transects were considered the independent observations for purposes of analysis.

We compared bird observations between streamside and upslope transects using an analysis of variance. Bird species diversity and total detections for each species with $\geq$30 detections were dependent variables.

Results

Mean bird species diversity and total bird abundance per transect were greater along upslope transects than along streams. Upslope areas accounted for 61 percent of the total number of birds detected and 91 percent of the bird species; in contrast, only 67 percent along streams. Thirty-three percent of the species were found exclusively in upslope areas, whereas nine 9 percent were found exclusively in streamside areas. Two of the species exclusively detected along streamsides were detected only on a single occasion.

Individually, more bird species were in greater abundance along upslope transects than along streams. Five species (brown creeper, chestnut-backed chickadee, dark-eyed junco, golden-crowned kinglet, and Hammond's flycatcher) were more abundant along upslope transects than along streams; Hammond's flycatcher was exclusively associated with upslope transects (Figure 1). Conversely, only

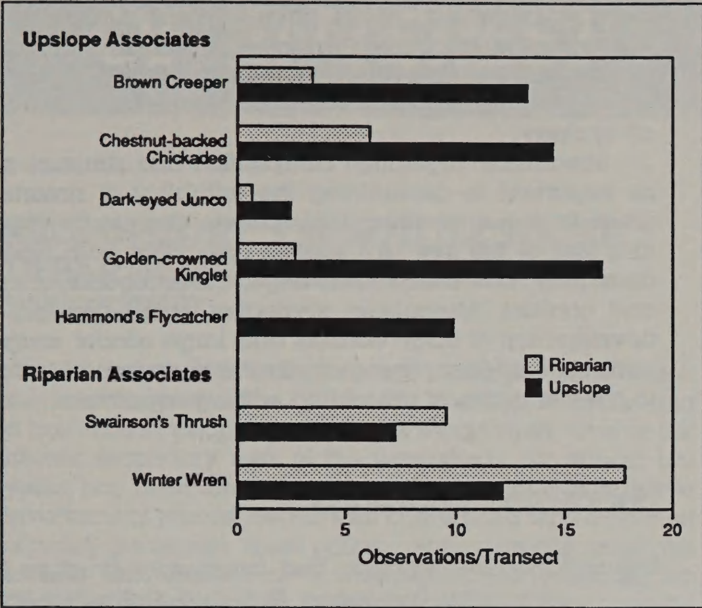

Figure 1. Comparison of bird observations along streamsides and upslope, Drift Creek Basin (from McGarigal and McComb 1992).

two species (winter wren and Swainson's thrush) were more abundant along streams than along upslope transects.

Discussion

Contrary to evidence that riparian areas support greater abundance and diversity of bird species than adjacent upland habitats in many areas, streamsides in Coast Range forests were dramatically less important than upslope areas in contributing to the avifauna of mature, unmanaged forest stands. Only three species were detected exclusively along streams, none of which seem to be strongly associated with second- or third-order streamsides in mature forests of the region. Winter wrens and Swainson's thrushes were associated with streamsides, but these species were also two of the most abundant species detected during this study, and both were common along upslope transects. Consequently, neither species could be considered a strong streamside associate. The remainder of the species detected along streams were either common cosmopolitan species or were detected in equal or greater numbers in upslope areas. Thus, streamside areas offered exclusive habitats for few terrestrial bird species during the breeding season.

Our results contrast markedly with the disproportionately high contributions of riparian areas to bird diversity in other environments. Most previous studies were conducted in relatively arid environments. There are at least three reasons why our results differed from others. First, in relatively arid environments, riparian areas often provide the only open water available for large areas. Consequently, animals that require open water for drinking or bathing must live in close proximity to riparian areas, resulting in disproportionately rich riparian animal communities compared to uplands. Because of abundant precipitation and high drainage densities in the Oregon Coast Range, open water in the form of small intermittent first-order streams, springs, and seeps is available within relatively short distances in upslope areas throughout most of the year. Consequently, animals that need open water for drinking and bathing may not require the close proximity of larger perennial streams. Second- and third-order streams may play only a minor role in determining animal distribution patterns.

Second, in relatively arid environments, transriparian gradients in microclimate are likely to be much more dramatic than in the Coast Range mountains of Oregon where the climate is moderated by the maritime influence. Consequently, any microclimatic influence on the energetic costs associated with factors such as thermoregulation or the distribution of invertebrates, which serve as a prey base for many forest vertebrates, may make riparian areas more favorable in arid environments. Such influences likely are less pronounced or perhaps absent in the central Oregon Coast Range.

Last, in relatively arid environments, high vertebrate species diversity in riparian areas, compared to surrounding uplands, may be attributable to the higher structural complexity and floristic richness of riparian vegetation. In the moist coniferous forests of our study area, however, vegetation structure may be less important because the surrounding uplands are forested, and the transriparian gradients in vegetation structure are relatively subtle. In our study, upslope areas contained important structural characteristics, such as abundant large conifers and snags, that were absent from many of the streamside areas. The scarcity of large conifers along these mountain streams may be related to geomorphic disturbance patterns (e.g., frequent debris flows) that favor tree species like red alder. Lower snag densities along streams likely resulted from there being fewer large conifers. Large conifer snags persist much longer than hardwood snags and account for most decay class 4-6 snags present in the study area. The presence of these particular structural features in upslope areas may explain the greater bird species richness we observed there.

Scope and Limitations

The scope of our study was restricted in several ways. These limitations identify additional research needs and should be understood carefully before these results are applied in a management context. First, the geographic scope of our study was limited to Drift Creek basin; it is uncertain whether the patterns we observed hold for the entire central Oregon Coast Range or beyond, although we believed the sites we sampled were typical of the region.

Second, our sampling was limited to the interior of mature, unmanaged coniferous and mixed coniferous-deciduous stands. We are unable to infer about patterns in young, managed stands or about potential animal associations in narrow streamside buffer strips of mature forests.

Third, our study was limited to second- and third-order streams. Results from other studies suggest that streamside versus upslope associations may vary significantly along the intrariparian gradient. Species richness and the number of unique species found along streamsides may be greater than upslope forests further downstream where edaphic, hydrologic, and geomorphic conditions interact with geo-

morphic disturbance processes to create a larger and more distinct (i.e., unique) riparian vegetation community.

Fourth, our sampling was limited to diurnal birds during the breeding season. Nocturnal birds were not included in our quantification of bird communities and, more importantly, we did not assess seasonal changes in streamside-upslope bird associations. Bird community organization is known to fluctuate seasonally in a variety of habitat types, including riparian areas.

Finally, our sampling was designed to estimate relative abundance of birds in plant communities adjacent to streams (i.e., streamsides) and upslope areas based largely on aural detections of singing and calling birds (96 percent of detections were aural). We did not attempt to assess bird use of the stream itself either by water-associated species (e.g., American dippers, mallards, etc.) or by terrestrial species. Consequently, upslope birds may have gone undetected if they periodically used streams without vocalizing, or drank and bathed during afternoons or evenings.

Management Implications

The strength and durability of the current riparian-wildlife conceptual model is based on its general applicability and its strong communicative power. However, the very strength of this conceptual model has inhibited researchers and land managers from questioning its applicability in specific environmental settings and has led land managers and others to believe that riparian areas universally support more species and numbers of vertebrates than uplands. As a result, those land managers interested in biodiversity have often focused wildlife management efforts on riparian areas with less regard for uplands.

In western Oregon, for example, riparian management strategies have been developed for the protection of multiple forest resources, including water, fish, and wildlife, and management efforts often have given disproportionate attention to riparian areas because of the these multiple resource values. However, these efforts have proceeded with little or no quantitative understanding of how riparian areas contribute to the needs of terrestrial vertebrates across the landscape.

It has been widely assumed that streamside areas provide habitat for more species of birds than do other habitats. Our results suggest that this assumption may not be true for diurnal birds along second- and third-order streams in mature forests. Riparian management alone may not meet the needs of vertebrates of mature forest stands of the central Oregon Coast Range; a landscape-level approach that considers upslope habitat and riparian habitat in conjunction may be more effective.

Land managers may wish to consider expanding riparian corridor width to include optimal habitat for species associated with mature forests and upslope areas, although further research is necessary to determine the appropriate corridor width for each species. Alternatively, upslope corridors of mature forest could be maintained and intervening managed forest stands could be made more permeable to these species by retaining significant amounts of within-stand structure (e.g., snags, large conifers) during harvest. A coordinated network of upslope and streamside mature forest corridors to connect mature forest patches with permeable intervening stands may be the most effective overall strategy.

Streamside vegetation composition and structure may be important in determining the suitability of streamside areas for some breeding bird species. Our results suggest that four of the five bird species associated with upslope areas may have been responding to the distribution of snags and conifers. Silvicultural strategies which promote the development of large conifers and large conifer snags in some streamside areas may make these areas more suitable to species currently associated with upslope areas.

Suggested Readings

Layman, S. 1984. Riparian bird community structure and dynamics: Dog Island, Red Bluff, California. Pages 587-597 in California Riparian Systems: Ecology Conservation, and Productive Management. R.E. Warner and K.M. Hendrix, ed. University of California Press, Berkeley.

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Oakley, A.L., J.A. Collins, L.B. Everson, D.A. Heller, J.C. Howerton, and R.E. Vincent. 1985. Riparian zones and fresh-water wetlands. Pages 57-80 in Management of Wildlife and Fish Habitats in Forests of Western Oregon and Washington. E.R. Brown, tech. ed. U.S.D.A. Forest Service, Pacific Northwest Region, Portland, Oregon. Publication No. R6-F&WL-192-1985.

Odum, E.P. 1979. Ecological importance of the riparian zone. Pages 2-4 in Procedures Symposium on Strategies for Protection and Management of Floodplain Wetlands and other Riparian Ecosystems. R.R. Johnson and J.F. McCormack, tech. coord. U.S.D.A. Forest Service, Washington, D.C. General Technical Report WO-12.

Rice, J., B.W. Anderson, and R.D. Ohmart. 1980. Seasonal habitat selection by birds in the lower Colorado River valley. Ecology 61:1402-1411.

Thomas, J.W., C.Maser, and J.E. Rodiek. 1979. Riparian zones. Pages 40-47 in Wildlife Habitats in Managed Forest—the Blue Mountains of Oregon and Washington. J.W. Thomas, tech. ed. U.S.D.A. Forest Service, Washington, D.C. Handbook No. 553,.

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OF INTEREST

"BIOFORESTRY" ON SEATTLE WATER DEPARTMENT'S CEDAR RIVER WATERSHED

The Seattle Water Department manages three watersheds for the production of drinking water for over one and a half million people in the Puget Sound area. One of the historic secondary uses of the watersheds, for almost 100 years, has been timber harvest. However, in 1985 a public involvement process began that culminated with a new set of policy guidelines. These policies place a greater emphasis on non- consumptive use of watershed forest resources. The Cedar River Watershed is the largest watershed and was the primary focus during the public process. Only about 16 percent of the 90,000 acre watershed has late successional forest cover. The policies call for placing all remaining old-growth and 50 to 65 percent of the younger forests into a reserve status and managing for water quality and wildlife habitat objectives. The remaining area of the watershed will provide a land base for developing a long-term timber harvest program. During 1990 the Water Department developed harvesting plans for balancing values of pending land and timber exchanges within the Cedar River Watershed. These exchanges provided an opportunity to develop silvicultural and harvest unit design strategies for contributing to structural and biological diversity on a stand level. The large reserve area on the watershed will likely meet landscape level needs for wildlife habitats and ecosystem processes; however, the Department believes that organisms will also benefit from actions taken to retain structural diversity in harvested stands.

As we began discussing how we should develop new forestry practices, we soon coined the term "Bioforestry" to describe Department efforts to blend biodiversity with forest management. We felt this term reminded us that forestry is a form of biology and that there is more to the forest than trees.

We began our planning process by establishing objectives for addressing stand level processes. We intended to address landscape level processes and patterns through a comprehensive management plan for the entire watershed. Fundamental to our objectives was the notion of providing a structural legacy that would carry forward through time and benefit species typically impacted by intensive even-aged management. In the simplest of terms this called for developing harvest prescription that retained green trees and coarse woody debris. Harvesting has been completed on 360 acres using a variety of strategies and designs.

Three distinctly different designs are illustrated in this article. The first example is an aggregated peninsular cutting pattern (Figure 1), the second is a dispersed green tree retention system (Figure 2), and the third is a modified group selection (Figure 3). The unit designs and prescriptions responded to existing stand structures and desired future conditions (See Table 1).

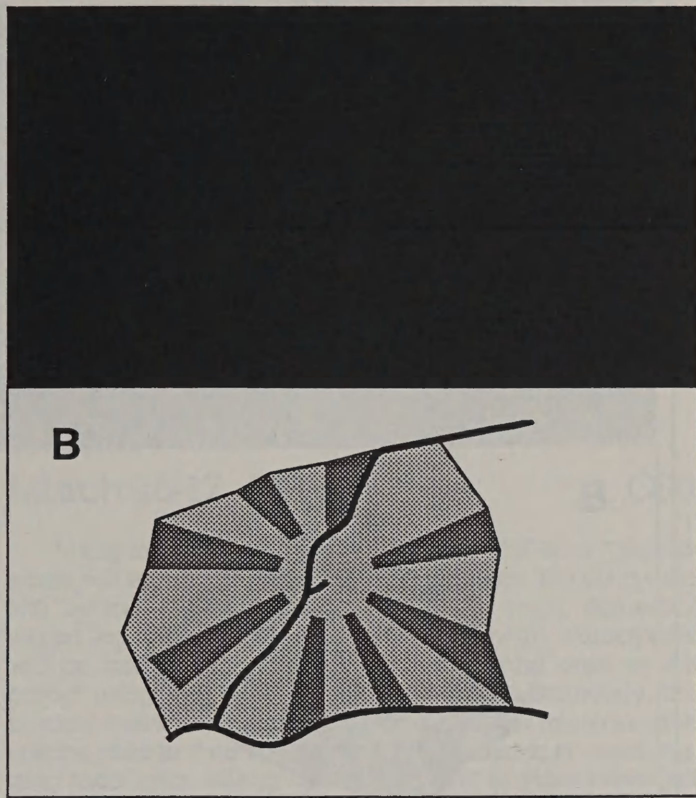

Figure 1A & 1B. Photograph and diagram of peninsular aggregated design (for details, see Table 1).

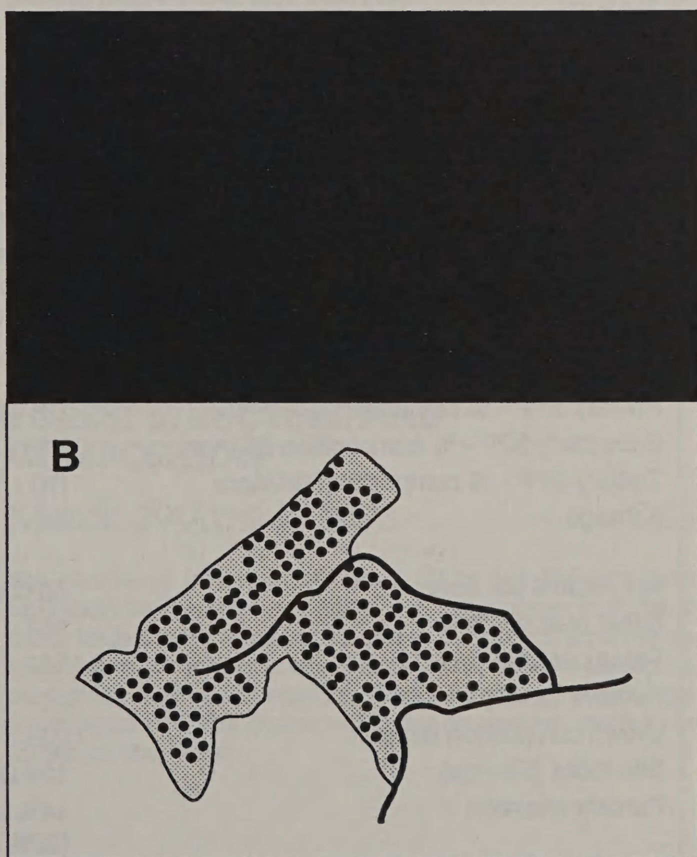

Figure 2A & 2B. Photograph and diagram for dispersed green tree retention system (for details, see Table 1).

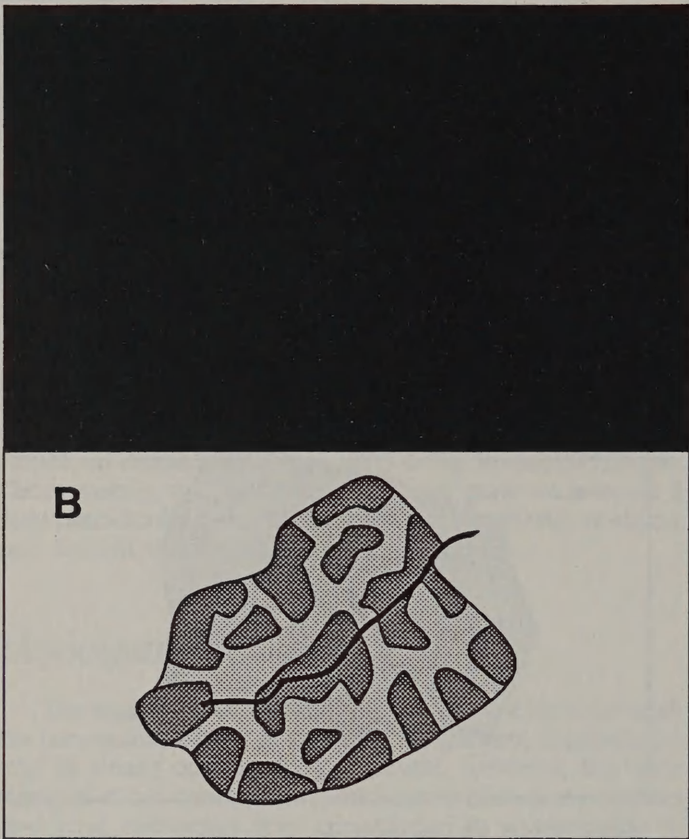

Figure 3A & 3B. Photograph and diagram for modified group selection with high density dispersed retention (for details, see Table 1).

To begin the process we examined the stands to develop an understanding of species composition, stand structure, the location and abundance of snags and downed woody debris, and any other attributes that would contribute to meeting treatment objectives. The stand examinations provided the framework for identifying potential concerns for blowdown, regeneration, safety, and future growth and yields. The desired future condition for all three stands was to contribute to vertical diversity by creating conditions for development of two or more canopy layers within treated stands. Vertical diversity objectives also included provisions for maintaining or recruiting snags, cavity trees, and trees with branching characteristics or forms that could be used by various species. Horizontal diversity was also a part of the desired future condition. We tried to create spatial variability within stands to develop various light regimes with resulting understory composition and development.

All units are in second growth stands that ranged from 55 to 70 years in age at the start of the experiment. Elevations range from 1,100 feet to 1,500 feet above sea level. The topography is generally flat and the areas were logged using ground-based equipment. We primarily focused on retaining dominant Douglas-fir as the preferred leave tree. These dominants have been more exposed to the wind over time and may have a lower susceptibility for blow down. These trees will be retained through the next rotation. At that time, enough balance may be restored to the landscape to allow that some of these large, high-quality trees to be harvested.

The units will be planted with a mixture of species that correspond to microsite conditions within the units. Areas with greater crown closure or shading will be planted with

Table 1. Stand characteristics for Cedar River Watershed bioforestry harvest units.

Stand information for each stand	Peninsular aggregated design	Dispersal green tree retention	Modified group selection
Primary SPP - % composition BA/Acre	DF - 67%	DF - 71%	WH - 52%
Secondary SPP - % composition BA/Acre	WH - 20%	RC - 16%	DF - 34%
Tertiary SPP - % composition BA/Acre	RC - 11%	WH - 12%	RC - 11%
Acreage	40	60	44 acres in gaps (39 acres in retention)
Net volume per acre	50,000	43,000	32,000
Basal area per acre	261	269	327
Trees per acre	162	172	363
Relative density	26	65	91
Crown competition factor	295	316	418
Site index (50 year)	138 DF	129 DF	110 DF
Percent retention	14% of Vol. (20% of area)	20% of Vol. (12 Trees/acre)	16% of Vol. (50 TPA retained)
Falling, bucking, and yarding costs/MBF (As reported by contractor)	$58	$43	$44

shade-tolerant species; open areas will receive shade intolerant species.

We have begun monitoring effects of blowdown, change in tree geometry, understory vegetation development, and regeneration. A wildlife-monitoring plan will be developed this winter. Unfortunately, because of time constraints, we were unable to conduct preharvest surveys to estimate wildlife usage or populations. We do intend to develop a plan for monitoring and recording usage of the harvest units by key species. There have been at least three storms with winds around 50 miles per hour within the units. Only about 15 trees have been lost to windthrow over the 360 acres.

We have seen that it is operationally feasible to create a legacy that will provide short-term benefits to some species and possibly provide future stand structures that will benefit other species in the coming years. By adopting bioforestry on the Seattle city watershed, we are attempting to learn new information through a willingness to set aside our old paradigms and try something new.

We are in the process of summarizing harvest activities and anticipate having copies available for distribution in early 1993. Anyone interested in receiving a copy can write to the Seattle Water Department, Attention: Marc McCalmon, 19901 Cedar Falls Rd. SE, North Bend, WA 98045.

Marc McCalmon,
Seattle Water Department,
Watershed Management,
Jerry Franklin,
University of Washington,
Olympic Natural Resources Center

OPPORTUNITIES

From the OSU College of Forestry Conference Office:

PHOTOGRAMMETRY AND AERIAL PHOTO INTERPRETATION

March 1-5, 1992 OSU

This short course is presented as a service to practicing foresters and others who are using, or will be using, aerial photos in their work. The course presents the fundamentals of photo interpretation and photogrammetry as well as the most advanced methods of field application.

SILVICULTURE INSTITUTE: MODULE 4—FINANCIAL ANALYSIS AND DECISION MAKING

March 8-19, 1993 OSU

Participants examine the principles of economics and social science as they apply to silvicultural decisions. This session emphasizes use of models as tools for assisting the silviculturist with development of management plans for current and future stands.

IMPLEMENTING OPTIMAL BUCKING

March 16-17, 1993 OSU

Using the new commercial software "OSU-Buck," participants will set up an optimal bucking system. The data used will be for westside conditions (Scribner scale, domestic/export log prices, Douglas-fir second growth). Participants will be able to develop the input data and analyze the output using a desktop personal computer. Ultimately, the participants will be qualified to evaluate how this technique can be used in their operation. Consultants, appraisers, logging managers, falling contractors, and anyone interested in "merchandizing trees" should attend.

MODERN ANALYTICAL PHOTOGRAMMETRY

March 22-26, 1993 OSU

This course is presented primarily to introduce natural resource managers to modern photogrammetric techniques and equipment. Microcomputer-based programs are used to determine the orientation of aerial photos with respect to the ground coordinates. The uses for digital mapping, GIS data collection, and local unit planning directly from photos are emphasized.

FOREST STRUCTURE AND COMPOSITION

March 29-April 8, 1993 OSU

The two-week course is designed (1) to provide principles and tools for managing stands and landscapes in order to meet timber and wildlife objectives and (2) to increase interaction and trust among silviculturists, wildlife biologists, and other resource specialists in solving resource management problems. The course will focus on coastal and interior forests of the West.

RESOURCE POLICY, VALUES & ECONOMICS

March 29-April 9, 1993 OSU

This annual two-week workshop is conducted to enrich the knowledge of foresters and wildlife managers regarding policy, values, and economics. The workshop involves speakers, projects, field trips, panels, and other learning modes.

VARIABLE PROBABILITY SAMPLING

April 12-16, 1993 OSU

This course is as a service to foresters. Two popular methods of timber cruising will be covered in detail: Variable-Plot Sampling and Three-P-Sampling (Probability Proportional to Prediction). The course is suitable for relative beginners as well as those with experience who would like to brush up on the principles of the two methods and up-to-date computation techniques using hand calculators and microcomputers.

ADVANCED VARIABLE PROBABILITY SAMPLING

April 19-21, 1993 OSU

This course is designed for those who use and collect stand inventory information. It will provide more in-depth coverage of sampling methods and analyses than the course listed above. Participants will practice making better plans for collecting and using forest data.

COMMERCIAL THINNING & UNDER-PLANTING TO ENHANCE DIVERSITY OF FORESTS & STREAMS

April 22, 1993 Mapleton, OR

Managers and researchers have joined forces to install new experiments in order to gain much-needed information about ecosystem management. New experiments have been installed promoting structural diversity in upslope and riparian forests. This field forum is an opportunity to see these experiments in an early stage and discuss the underlying issues, assumptions, experimental techniques and management implications. The program will begin with an orientation to management on the Siuslaw National Forest and a brief overview of ecosystem management concepts. The last stop will focus on riparian zone and stream enhancement for fish habitat.

This field forum should appeal to wildlife biologists, resource managers, small woodland owners, silviculturists, loggers, foresters, and anyone interested in habitat enhancement for fish and wildlife.

TIMBER BRIDGE INSPECTION AND LOAD RATING ANALYSIS

April 27-29, 1993 OSU

The purpose of this course is to update field engineers with the current AASHTO (American Association of State Highway Transportation Officials) procedures for timber bridge inspection and vehicle load rating analysis. Elementary bridge mechanics will be reviewed; AASHTO vehicle load-rating analysis procedures will be covered in detail. A field inspection of a timber bridge will be made and an AASHTO vehicle load rating performed on the structure.

For more information on the above mentioned workshops, contact the Forestry Conference Office, Oregon State University, Peavy Hall 202, Corvallis, OR 97331-5707, or Telephone (503) 737-2329, FAX: (503) 737-2668.

RECENT PUBLICATIONS

CHARACTERISTICS OF NORTHERN FLYING SQUIRREL POPULATIONS IN YOUNG SECOND- AND OLD-GROWTH FORESTS IN WESTERN OREGON by D.K. Rosenberg and R.G. Anthony. 1992. Canadian Journal of Zoology 70:161-166. Northern flying squirrels are strongly influenced by stand structure and forest management activities. In addition, flying squirrels are the primary prey base of northern spotted owls throughout the Oregon Coast Range and most of the Pacific Northwest. Consequently, understanding the habitat relationships of northern flying squirrels is fundamental to providing suitable habitat for spotted owls. To unravel the relationship between stand age and flying squirrel densities in the Oregon Cascades, Rosenberg and Anthony conducted a 3-year live-trapping study in 10 stands in the Willamette National Forest. Unlike previous studies that have suggested that flying squirrel densities are highest in late seral stage forests, densities of flying squirrels reported in this study were not significantly different between young and old-growth stands (2.0 squirrels per hectare in second-growth stands, 2.3 squirrels per hectare in old-growth stands). Rosenburg and Anthony suggest that factors related to seral stage other than primary prey productivity, such as differences in vulnerability of prey in different habitats, secondary prey productivity, great horned owl predation on spotted owls, or microclimatic differences may account for the relationship between spotted owls and late seral stage forests.

JPH

SOCIETY OF AMERICAN FORESTERS TASK FORCE REPORT ON BIOLOGICAL DIVERSITY IN FOREST ECOSYSTEMS. 1991. Society of American Foresters SAF 91-03. Biological diversity is becoming an issue of increasing importance in the management of natural resources. This report defines biodiversity, discusses historical and conceptual aspects of biodiversity, and summarizes the effects of forest management practices on biodiversity and the unique parts that land owners and land managers can play in the conservation of biodiversity. The paper suggests that foresters should play a key role in the conservation of biodiversity.

JPH

COPE

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COPE Report

Coastal Oregon Productivity Enhancement Program

Promoting Integrated Management of Oregon's Coast Range Forests Through Research and Education

Volume 6, Number 1 | Winter 1993

From the Program Manager

Featured in this issue of the COPE Report are three studies that will contribute to a better understanding of riparian ecosystems, adjacent upslope sites, and the influence of management activities. The first deals with the effectiveness of headwall leave areas and the reliability of two methods commonly used in the Oregon Coast Range to assess the risk of headwall failure. The authors found that, of the headwalls surveyed, the percentage of leave areas that failed exceeded the failure rate of clearcut or timbered headwalls. The authors also evaluated the predictive value of two risk assessment methods used by federal land management agencies. One they found to be reasonably reliable, while the other had little predictive ability.

The second study deals with long-term effects of forest harvest activities on cutthroat trout populations. The principal investigator has made a real effort to minimize the influence of other factors, such as competition from coho salmon, on his evaluation. He has taken an interesting approach to the study which his article describes in some detail. The results of the study will be summarized later this year in a future issue of the COPE Report.

The third and final study summarized in this issue examined small mammal and amphibian populations in riparian and adjacent upslope forest stands. The authors found that small mammal diversity was greater in riparian areas than upslope sites, although there were certain species that were more highly associated with one habitat type or the other. Amphibian species diversity did not differ between habitat types, but, again, some species exhibited habitat preference. When coupled with the information on birds reported in an earlier issue of the COPE Report, these analyses provide important information for managers interested in maintaining wildlife species diversity.

As I read through these studies I was impressed by the quality of the research and the new information that has been acquired or will likely develop. I hope you find it as interesting as I have.

Steve Hobbs

Steve Hobbs

IN THIS ISSUE

COPE Report

This issue of the *COPE Report* was and produced by Doug Bateman, Gretchen Bracher, Elizabeth Dent, Skye Etessami, John Hayes, Arne Skaugset, Judy Starnes, and Gabe Tucker. The *COPE Report* is produced quarterly as a contribution of Adaptive COPE. Because of space limitations, articles appear as extended abstracts. Results and conclusions may be based on preliminary data or analysis. Readers interested in learning more about a study should contact the principal investigator or wait for formal publication of more complete results. Comments and suggestions concerning the content of the *COPE Report* are welcomed and encouraged. To receive this free newsletter, contact Adaptive COPE, 2030 S. Marine Science Dr., Newport, OR 97365, (503) 867-0220. Information concerning Adaptive COPE should be addressed to Gabe Tucker at the Adaptive COPE office. For specifics on the overall COPE Program, contact Steve Hobbs, COPE Program Manager, Forestry Sciences Laboratory, 3200 SW Jefferson Way, Corvallis, OR 97331, (503) 750-7426.

The COPE Program is a cooperative effort between Oregon State University's College of Forestry, the USDA Forest Service, Pacific Northwest Research Station, the USDI Bureau of Land Management, other federal and state agencies, forest industry, county governments, and the Oregon Small Woodland Association. The intent of the program is to provide resource managers and the public with information relative to the issues and opportunities associated with the management of fish, timber, water, wildlife, and other resources of the Oregon Coast Range. The COPE Program emphasizes an integrated approach—an integration of research and education and an integration of scientific disciplines—to find effective ways to manage these diverse resources collectively.

The COPE Program has two related components: Fundamental COPE and Adaptive COPE. Comprised of OSU and PNW scientists based primarily in Corvallis, Fundamental COPE addresses problems related to riparian zone management and reforestation in the Coast Range through basic research. Adaptive COPE is comprised of an interdisciplinary team responsible for applying and adapting new and existing research information to solve specific management problems. Stationed on the coast in Newport at the Hatfield Marine Science Center, the Adaptive COPE team is also responsible for providing continuing education opportunities to facilitate technology transfer.

ADAPTIVE COPE

NEW RESEARCH ASSISTANT AT ADAPTIVE COPE

This January, Kathleen Maas joined the Adaptive COPE staff in Newport. Kathy received a BS degree in Botany from the University of Maryland and her MS in Forest Ecology from Michigan State University. Her Master's thesis was an investigation of the effects of weeds on carbon and nitrogen partitioning in poplar plantations. Kathy brings a strong background in forestry and plant ecology to the program.

Kathy will be a Research Assistant with Adaptive COPE and will be involved in the full scope of wildlife, fisheries, silviculture, and hydrology studies that the team is conducting.

STREAM HABITAT: APPLICATION OF GEOMORPHIC AND ECOLOGICAL PRINCIPLES

Management of stream habitats has become an extremely important issue in the Pacific Northwest. To address this concern, resource managers have taken several different approaches to evaluating stream habitat. Successful habitat evaluation and management require integration of a broad knowledge base gathered from several different disciplines from both the physical and biological sciences.

From January 26 through January 28, 1993, Adaptive COPE and the OSU College of Forestry sponsored a symposium entitled "Stream Habitat: Application of Geomorphic and Ecological Principles" to provide a forum for discussion and synthesis of current approaches to stream habitat management. Over 300 people attended this three-day program that included speakers from the Bureau of Land Management, the Forest Service, Oregon Department of Fish and Wildlife, the timber industry, Oregon State University, and several other organizations and universities. Among the topics discussed were landscape approaches to management, physical and biological processes in streams, habitat evaluation procedures, data analysis, and future directions in stream habitat management.

The diversity of speakers brought a corresponding diversity of viewpoints and approaches to the symposium, but a number of consistent themes emerged from the meeting. There was general support for approaches to stream management that emphasize ecosystem and basin-level management and that take an integrative approach to management. Several different hierarchical stream classification systems were presented. Although the systems differed in detail, there was general consensus that hierarchical classification schemes represent a clear improvement over other techniques in quality of the data collected and that

hierarchical systems create a more logical framework for analysis and interpretation of the collected data. There was considerable discussion concerning techniques to make stream surveys more consistent, and although a number of interesting strategies were discussed, there was no clear consensus on this issue.

THE CONTRIBUTIONS OF DR. HENRY A. FROEHLICH TO FORESTRY

On Tuesday, November 17, 1992, approximately 115 people attended a one-day workshop cosponsored by Adaptive COPE and the OSU Forest Engineering Department on "Forest Soils and Riparian Zone Management: The Contributions of Dr. Henry A. Froehlich to Forestry." The primary purpose of the workshop was to honor the research accomplishments of Dr. Froehlich during his 22-year career with the Forest Engineering Department at Oregon State University. Dr. Froehlich, a Professor of Forest Hydrology, retired from OSU in June, 1992. During his research career, Dr. Froehlich conducted research on soil compaction, organic debris in streams, riparian zone management, and slope stability. Although the primary objective of the workshop was to honor Dr. Froehlich, presentation of some of Dr. Froehlich's recent research, such as the COPE research projects on windthrow in coastal Oregon bufferstrips and the effectiveness of headwall leave areas, was very timely and provided an excellent forum for dissemination of important information.

The workshop was kicked off by Dr. George Brown, Dean, College of Forestry at Oregon State University. Dr. Brown presented the keynote address entitled "Dr. Henry A. Froehlich - Scientist and Teacher." He was followed by Pete Cafferata, Forest Hydrologist for the California Department of Forestry, who presented an overview of Dr. Froehlich's research on soil compaction.

Dr. Froehlich's most significant contributions to this field include his pioneering research efforts on (1) the utilization of designated skid trails and (2) soil tillage to minimize soil compaction resulting from ground-based logging systems. Arne Skaugset, a hydrologist with the Adaptive COPE program, presented a synthesis of Dr. Froehlich's research on slope stability and general hydrology.

Arne reviewed Dr. Froehlich's recent work sponsored by Fundamental COPE on the effectiveness of headwall leave areas on slope stability. Some of this work is summarized on pages 3-6 in this issue of the _COPE Report_. After lunch, Dale McGreer, Resource Hydrologist with the Potlatch Corporation, and Chip Andrus, Forest Hydrologist for the Oregon Department of Forestry, teamed up to present a synthesis of Dr. Froehlich's research on organic debris in streams and riparian zone management. Dr. Froehlich initiated considerable work on the amount of woody debris occurring naturally in streams, and on the influence of forest management techniques on woody debris in streams. Some of his early work concerning woody debris examined ways to reduce the amount of woody debris introduced to the stream by forest management. Later studies concerned the recovery of streamside vegetation after timber harvest. The presentations were culminated by comments and observations from the day's honored guest, Dr. Froehlich.

During lunch, presentations were made to Dr. Froehlich from the OSU Forest Engineering Department, USDA Forest Service Pacific Northwest Research Station, and Dr. Froehlich's alma mater, Colorado State University.

The proceedings of the workshop have been assembled, and a limited number of copies are still available. The proceedings include papers by all the speakers, an annotated list of thesis by Dr. Froehlich's graduate students, and an annotated bibliography of Dr. Froehlich's published papers. If you would like a copy please write Adaptive COPE, Hatfield Marine Science Center, Newport, OR 97365, or call (503) 867-0220.

FOREST MANAGEMENT ON LANDSLIDE PRONE SITES: THE EFFECTIVENESS OF HEADWALL LEAVE AREAS

The combination of steep slopes and abundant rainfall makes landslides the dominant form of erosion along the Coast Range of Oregon. Timber harvesting can increase the frequency and size of landslides, as well as the distance that landslides travel. The accelerated erosion induced by harvesting is often separated into two categories: road-related landslides and in-unit landslides (landslides not associated with logging roads). During the last 10 to 15 years, the incidence of road-related landslides in the Oregon Coast Range has declined substantially as a result of increased road standards and improvements in planning, layout, construction techniques, and maintenance practices. As the incidence of road-related landslides declines, increased attention is being given to the problem of in-unit landslides. On federally owned forest land in the Oregon Coast Range, one method used to reduce the incidence of in-unit landslides is retention of patches of uncut timber left in potentially unstable headwalls. These patches of timber are known as headwall leave areas.

Two methods are currently used by federal forest land management agencies in the Oregon Coast Range to rate headwall stability. The Siuslaw National Forest uses the Mapleton Headwall Risk Rating System. In this system, descriptive characteristics of headwalls are given numerical ratings that are summed to yield a final rating (see the paper by Swanson and Roach listed in the Recommended Readings for additional information). The Bureau of Land Management uses the Level I Stability Analysis, or LISA, and it's three-dimensional version, 3DLISA, to assess slope stability. LISA and 3DLISA are based on a model called the infinite slope method and account for a series of empirical relationships for effects such as root strength and groundwater along with the mechanics of the slope stability model (see the LISA User's Manual by Hammond et al. listed in the Recommended Readings for additional information).

The effectiveness of headwall leave areas in reducing the incidence of landslides and the ability of the two stability rating methods to predict slope instability have never been adequately tested. Thus, in 1987 a Fundamental COPE

research project was instituted to compare and evaluate the existing methods of determining headwall stability and to evaluate the effectiveness of headwall leave areas in reducing the incidence of landslides in harvested headwalls. This article presents preliminary results from this research project.

Methods

To evaluate the two stability rating methods and headwall leave area effectiveness, we assembled an inventory of 276 headwalls in the central Oregon Coast Range. Of the headwalls inventoried, 123 are located on the Mapleton Ranger District of the Siuslaw National Forest and 153 are located on the Coast Range Resource Area of the Bureau of Land Management's Eugene District. Of these, 180 are forested, 70 are clearcut, and 26 are within headwall leave areas in harvested units. All of the clearcut and clearcut with leave area headwalls were harvested 7 to 20 years prior to the inventory.

We collected site and vegetative data in the field from all of the headwalls considered in the study. The Mapleton Headwall Rating System and 3DLISA were used to evaluate the stability of the headwalls. Most of the information we collected at each headwall was required to satisfy the input needs of 3DLISA, which requires identification of the area in the headwall most prone to landsliding, known as a landslide block, and the location where the headwall is most constricted or where the groundwater converges, known as the critical point. It is thought that landslides are most likely to initiate at the critical point. Once the critical point was identified, the block's length, width, soil depth, slope, sideslope, and azimuth were measured. The overstory and understory vegetation on the headwall was described and the presence of trees in the vicinity of the critical point was noted. Finally, the failure status of the headwall was recorded and the presence of geomorphic indicators of instability such as tension cracks, pistol-butted trees, hummocky microrelief, and the presence of scattered or widespread windthrow was recorded. The Mapleton Headwall Risk Rating was calculated in the field for 269 of the 276 headwalls. Once the headwalls had been inventoried and a database assembled, the probability of failure was calculated with 3DLISA with both maximum and minimum root strength for all 276 headwalls.

Risk Rating Methods Results

For our analyses, we assume that as landslide risk or the probability of failure of headwalls increases, the proportion of headwalls that have failed should increase also. Thus, if the slope stability ratings reflect actual risk, there should be a close relationship between the slope stability rating and the proportion of headwalls that have failed. As a test of the slope stability rating systems, only the forested headwalls in the inventory were used. Each of the two rating systems were divided into arbitrary stability classes and the percent failed for each stability class was plotted against increasing risk.

We calculated the probability of failure for the 180 forested headwalls in the inventory with 3DLISA based on the maximum root strength. The 3DLISA probability of failure ranged from 0 to 0.95 with an average of 0.29. A Mapleton Headwall Risk Rating was calculated for 166 forested headwalls and ranged from 23 to 60 with an average of 37.3. The 3DLISA probability of failure values were arbitrarily divided into four equal categories in which each category covered one quarter of the range of the probability values. Two arbitrary stratifications were used for Mapleton Risk. For the first analysis, we expanded the three risk categories used by the Forest Service: sites with less than 35 are considered at low risk, sites with ratings between 35 and 48 are considered to be at moderate risk, and sites with ratings greater than 48 are considered to be at high risk of failure. To obtain more detailed information from the data, we examined a second stratification with seven categories. The first category included all sites with ratings less than or equal to 30 and subsequent categories were divided in five point increments through the maximum rating of 60.

Our results suggest that the Mapleton Risk evaluation is relatively effective in evaluating risk, whereas 3DLISA has poor predictive value. Using the Forest Service low, moderate, and high risk rating categories, the percent headwalls failed for each category clearly shows an increasing trend (Figure 1). This trend is also evident when the data is examined using seven risk rating categories (Figure 2). Caution should be used when interpreting the results using seven risk categories. Small sample sizes for the sites with highest risk rating categories precludes precise estimation of percent headwall failure rates for this group. However, above a risk rating of approximately 40, no increasing trend is evident and the rate of failure varies around 50 percent. The failure probability estimated using 3DLISA has virtually no predictive value (Figure 3). The category with the lowest estimated probability of failure had the highest actual fail-

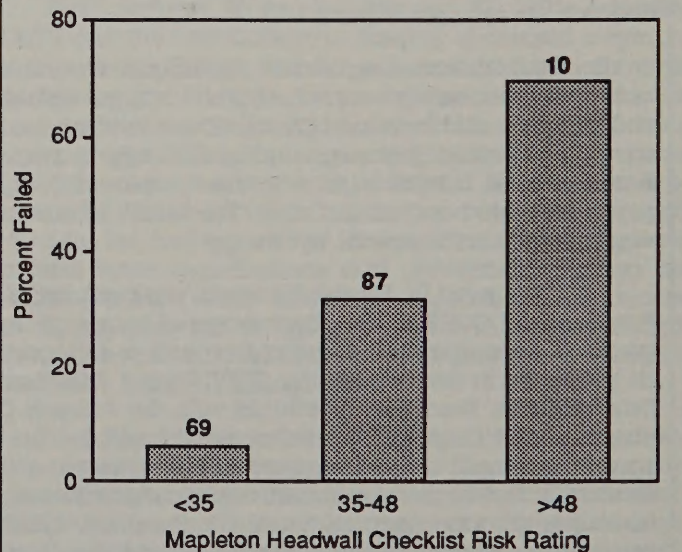

Figure 1. The percent of forested headwalls failed for three risk categories of the Mapleton Headwall Risk Rating System. Total number of headwalls examined for each risk category is provided above the bars.

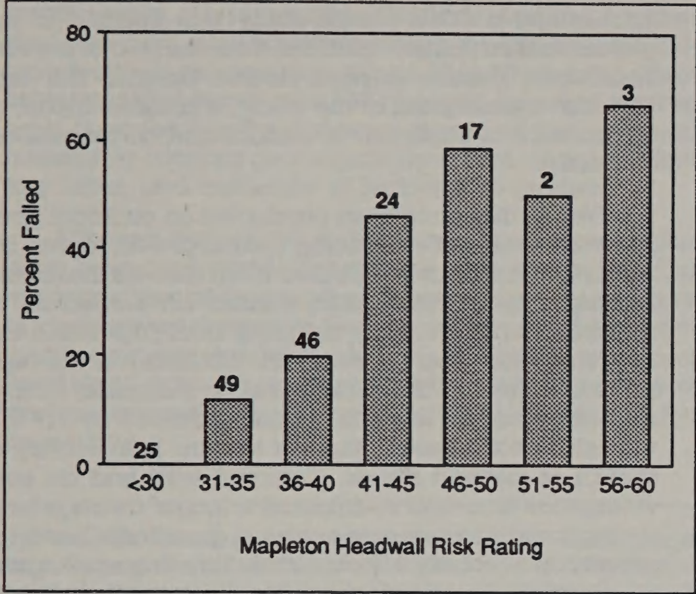

Figure 2. The percent of forested headwalls failed for seven risk categories of the Mapleton Headwall Risk Rating System. Total number of headwalls examined for each risk category is provided above the bars.

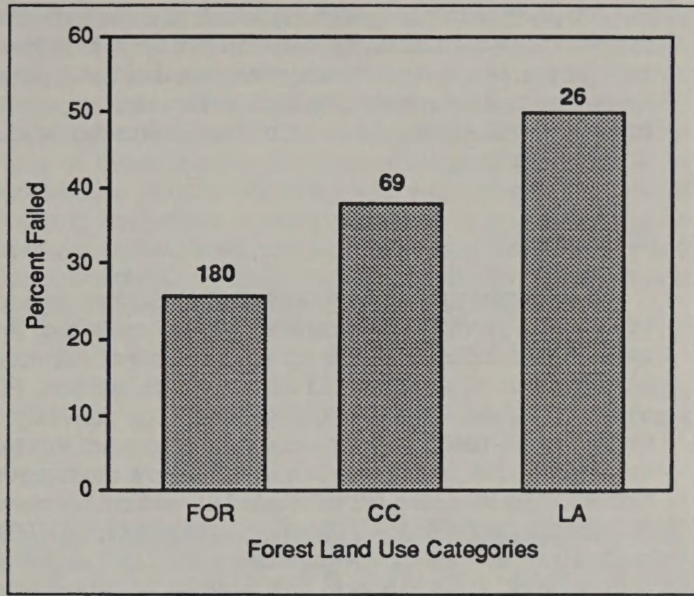

Figure 4. The percent failed headwalls for three forest land use categories for all headwalls in the inventory. FOR, forested headwalls; CC, clearcut headwalls; LA, clearcut headwalls with leave areas. Total number of headwalls examined for each risk category is provided above the bars.

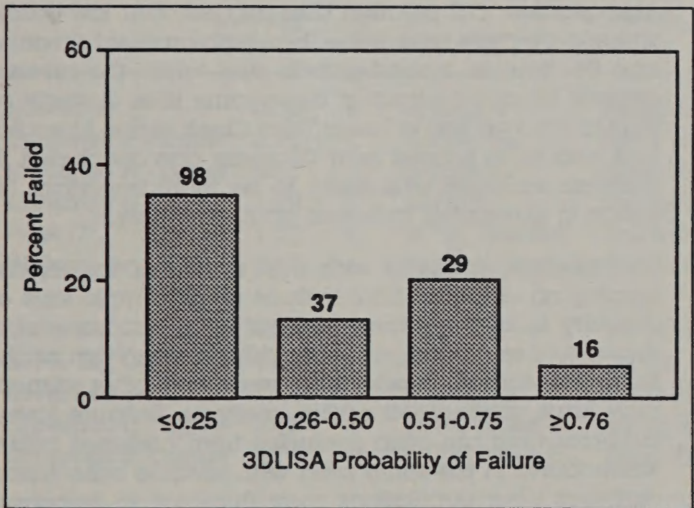

Figure 3. The percent of forested headwalls failed for four risk categories with the 3DLISA probability of failure calculation with maximum root strength. Total number of headwalls examined for each risk category is provided above the bars.

ure rate and the category with the highest probability of failure had the lowest percent failure.

Headwall Inventory Results

The results of the headwall inventory are shown in Figure 4. The headwalls that were clearcut with leave areas retained had a 50 percent failure rate, followed by clearcut headwalls (38 percent failure rate), and forested headwalls (26 percent failure rate). These results were not anticipated. Headwall leave areas are prescribed so that the existing root mat will remain intact. Thus headwalls in leave areas and those in forested areas should not differ in soil strength due to root reinforcement in the critical portion of the headwall. However, our results suggest that there may be significant differences in soil strength between forested headwalls and clearcut headwalls with leave areas.

Two hypotheses are presented that might explain this result. First, headwall leave areas may cause an increase in failure rate. Only two of the 13 headwall leave areas that did not fail experienced windthrow. One of these was described as having scattered windthrow and the other as having widespread windthrow. In contrast, of 13 headwall leave areas that did fail, six experienced windthrow, with four described as scattered and two as widespread. We suspect that the primary mechanism resulting in an increased failure rate is windthrow.

The second hypothesis that might explain the difference in failure rate is that headwall leave areas may have only been retained in the most inherently unstable headwalls. As a preliminary evaluation of this hypothesis, we conducted an analysis of variance comparing each of the forest landuse categories for differences in mean slopes and mean sideslopes of the headwalls. Because we found the Mapleton Headwall Risk Rating System to be a good predictor of slope stability, an analysis of variance comparing treatment means of Mapleton Risk Ratings was also performed. Mean slope, mean sideslope, and mean Mapleton risk rating all were significantly different between the three treatments. In each case the mean for the headwall leave areas was greater than means for the forested and clearcut areas. This suggests that the headwalls that had leave areas prescribed may have been inherently more unstable than were headwalls in the other land use categories.

It is not possible to determine which of these hypotheses provides the explanation for higher failure rates of headwalls with leave areas. The two hypotheses are not mutually exclusive, and we suspect that both of these factors, possibly in concert with others, account for the observed differences in failure rates.

Summary

The Mapleton Headwall Risk Rating System is a relatively good predictor of landslide risk in headwalls. However, interpretation of failure rates for headwall risk ratings above about 40 to 45 should be used with caution. Probability of failure, calculated with 3DLISA, as currently understood and used, does not adequately predict landslide risk. Finally, harvested headwalls with leave areas have a higher failure rate than either forested or clearcut headwalls. This may be an artifact of the management and sampling process or because headwall leave areas actually cause failures. It is, most likely, a combination of these factors. Analysis of the headwall inventory dataset will continue so that more progress can be made toward resolving these and related questions.

Recommended Readings

Swanson, F.J., and C.J. Roach. 1987. Administrative report of the Mapleton Leave Area Study. USDA Forest Service, Pacific Northwest Research Station, Corvallis, Oregon. 141 p.

Hammond, C., D. Hall, S. Miller, and P. Swetik. 1992. Level I Stability Analysis (LISA) Documentation for Version 2.0. USDA Forest Service, Intermountain Forest and Range Experiment Station, Ogden, Utah. General Technical Report INT-285.

Arne Skaugset,
Adaptive COPE
Hank Froehlich,
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Washington Department of Fisheries

LONG-TERM RESPONSE OF RESIDENT COASTAL CUTTHROAT TROUT TO FOREST HARVEST: DESCRIPTION OF STUDY AND PROGRESS REPORT

Introduction

In western Oregon, harvest of second-growth timber is likely to increase in the near future. Over the next 30 years, the second-growth forest stands that will be ready for harvest were last harvested before the adoption of Oregon's Forest Practice Rules in 1972. Little is known about the long-term response of resident cutthroat trout to the first harvest in watersheds of northwestern Oregon. To fill this gap in our knowledge, a COPE funded study was initiated to study populations of resident cutthroat trout and use of harvested headwater streams in northwestern Oregon. This article provides a description of the study, a progress report, and a discussion of important limitations and considerations of the study.

Few studies have been conducted on cutthroat trout in streams bordered by maturing second-growth forests. Studies of Needle Branch in the Alsea Basin showed that clearcut logging without buffer strips caused an immediate and sustained decrease in the cutthroat trout population up to 20 years after forest harvest. In tributaries of the upper McKenzie River in the central Oregon Cascades, cutthroat trout biomass was lower in streams bordered by 12- to 35-year-old second growth than in streams bordered by old-growth or clearcut stands. Cutthroat trout had an earlier emergence time and maintained a longer average length during their first summer in a second-growth site than in old-growth and recently clearcut sites. Standing stock, growth rate, and production of fish at age 0+, as well as standing stock and mean weight of fish at age 1+, were reported to be lower for cutthroat and rainbow trout found in 30- to 40-year-old second-growth sites in comparison to fish in other old-growth and clearcut watersheds in the Oregon Cascades. In addition, data from low-gradient (1 percent) and high-gradient (10 percent) sites suggest that low-gradient streams are more productive than high-gradient streams for age 0+ trout in second-growth sites while the reverse is evident for age 1+ trout at these same sites. A study conducted on a portion of lower Tobe Creek in the Alsea Basin that had been logged over 20 years ago concluded that instream structure was likely to be more important than shade in governing cutthroat trout abundance.

Common problems with past studies of the effects of logging on cutthroat trout include small sample sizes and difficulty in distinguishing resident from anadromous cutthroat trout and young-of-year cutthroat trout from rainbow trout or steelhead. In addition, presence of other salmonids may have confounded earlier analyses. Because juvenile cutthroat trout are often excluded from preferred habitats when found in the same area with juvenile coho salmon, cutthroat trout populations may fluctuate in response to coho salmon populations. My conclusion from a review of past studies was that cutthroat trout populations in second-growth drainages were in need of further study and that it would be desirable to study populations of cutthroat trout free of anadromous trout and salmon interaction.

Methods and Progress to Date

A search was conducted to find first- and second-order headwater streams from west-side watersheds of the central Oregon Coast Range containing populations of resident coastal cutthroat trout free of anadromous trout and salmon. Streams chosen for sampling were in forest stands that were harvested at least 20 years ago. Watersheds that had experienced multiple harvest entries over an extended period of time were not considered for sampling .

During the summers of 1991 and 1992, 16 reaches from 13 streams were sampled for habitat characterization and

assessment of fish populations (Table 1). Of the 13 watersheds sampled, nine have relatively homogeneous second-growth stands ranging in age from 20 to 60 years and four have unlogged stands over 100 years old. Sampled reaches were of varied lengths and were chosen so that they had a relatively constant geomorphic constraint, no major tributary input, and moderate- to high-stream gradient.

Although data on fish habitat and population densities have been processed for most of the streams sampled, the major analyses addressing the pattern of long-term response to forest harvest depend on the full complement of data from the streams sampled to ensure adequate representation of forest stand ages. A paper detailing the methods employed and results generated will appear in the COPE Report in the near future.

Table 1. List of stream reaches sampled during 1991-92. Drainage area represents size of watershed above the most downstream point of reach sampled. All basins listed are west-side drainages of Oregon's mid-Coast Range. Stand age classes are: I (20-35 yrs), II (40-60 yrs), III (>100 yrs).

Stream	Drainage area (km^2)	Stand age class	Subbasin	Basin at ocean entry
Needle Br.	0.53	I	Drift Cr.	Alsea R.
Unnamed A - Upper	0.70	I	Euchre Cr.	Siletz R.
Unnamed A - Lower	0.87	I	Euchre Cr.	Siletz R.
Unnamed B	1.29	I	Siletz R.	Siletz R.
Peak Cr.	1.52	I	S. Fk. Alsea R.	Alsea R.
Williams Cr.	3.47	I	S. Fk. Alsea R.	Alsea R.
Unnamed C	1.23	II	Peak Cr.	Alsea R.
S. Fk. Big Cr.	1.33	II	Big Cr.	Big Cr.
Unnamed D	1.92	II	Big Cr.	Alsea R.
Unnamed E - Upper	2.02	II	S. Fk. Alsea R.	Alsea R.
Unnamed E - Lower	2.70	II	S. Fk. Alsea R.	Alsea R.
Gopher Cr.	0.89	III	Drift Cr.	Alsea R.
Unnamed F	1.15	III	Dicks Fk.	Big Cr.
Unnamed G	1.43	III	Dicks Fk.	Big Cr.
Tobe Cr. - Upper	3.39	III	S. Fk. Alsea R.	Alsea R.
Tobe Cr. - Lower	4.88	III	S. Fk. Alsea R.	Alsea R.

Experimental Design Considerations

Efforts to describe distribution, habitat use, and basic life history aspects of resident populations of cutthroat trout are lacking. Studies of the distribution and density of resident cutthroat trout in areas above barriers lack the potential confounding factors presented by the seasonal and annual flux in anadromous populations and corresponding social interactions.

The primary question addressed by this study is whether cutthroat trout populations have a detectable and predictable response relative to the timing of past logging events. Occurrence of natural disturbances such as floods and landslides have the potential to confound the analysis; interactions of these factors with time of logging will need to be addressed. Deciphering long-term responses to the style of logging long since abandoned in western Oregon can be useful in assessing what measures are needed to ensure that logged watersheds begin or continue to heal and provide healthy habitat for indigenous cutthroat trout.

Pat Connolly,
OSU Fisheries and Wildlife Department

FUNDAMENTAL COPE

STREAMSIDE VERSUS UPSLOPE ASSOCIATIONS OF SMALL MAMMALS AND AMPHIBIANS

Several authors have claimed that riparian areas generally support a greater number of vertebrate species and greater abundances of many species than adjacent uplands. These results stem largely from studies in relatively arid environments where transriparian gradients in microclimate and vegetation are pronounced. Prior to this study, it is unclear whether these results would apply to moist coniferous forests in western Oregon where transriparian gradients are less dramatic. In the Winter 1992 issue of the COPE Report, we reported the results of our investigations of the value of second- and third-order streamside areas to breeding birds in mature, unmanaged forest stands in the central Oregon Coast Range. Here we review our findings of habitat associations of small mammals and amphibians in the same habitats. Specific methods and findings are described elsewhere (see Suggested Readings).

Study Area and Methods

We selected six second- and third-order streams in large (>60 ha), mature, unmanaged forest stands distributed throughout Drift Creek Basin, Lincoln County. We established two 700-m transects along each of the six streams: (1) a streamside transect located adjacent (≤20 m) and parallel to the stream axis, and (2) an upslope transect located 400 m upslope and parallel to the stream transect. We established eight sample points at 100-m intervals along each transect for a total of 48 streamside and 48 upslope sample points distributed evenly over the six stands. All

sample points were $\geq$100 m from the nearest forest edge created by a road or young ($\leq$30 years), managed stand.

We placed two pitfall traps (double-deep No. 10 tin can) within 5 m of each sample point. Snap trap (Museum Special) stations were placed every 20 m along the streamside and upslope transects. Two traps were set at each snap trap station in the wet season. We sampled stands in random order between 3 May and 28 June (the wet season) and between 8 September and 15 October (the dry season), 1988. Sampling was conducted during periods when the influence of the stream on use of riparian habitat by vertebrates may have been high (dry season) or low (wet season). Within each stand, we set and checked Museum Specials daily during the first 5 sampling days (9,600 trap nights); the pitfalls were opened and checked weekly for 1 month (10,800 trap nights/season). Snap trapping was abandoned in the dry season as unnecessary because pitfalls sampled all but two of the common species that had been captured during the wet season.

We compared small mammal and amphibian captures between streamside and upslope transects using an analysis of variance. Mammal and amphibian species diversity and total captures for each species with $\geq$30 captures were dependent variables.

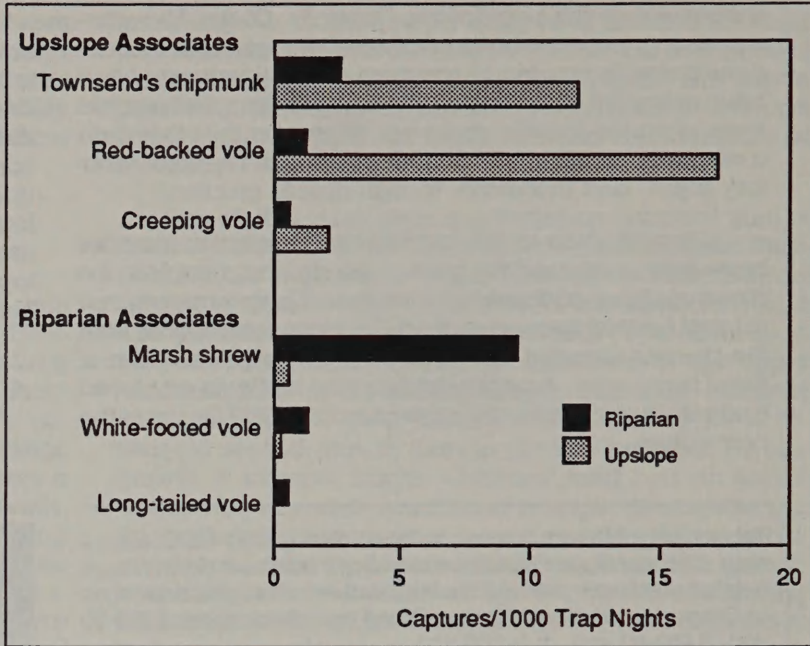

Figure 1. Comparison of small mammal captures along streamsides and upslope, Drift Creek Basin (from McComb et al. 1993).

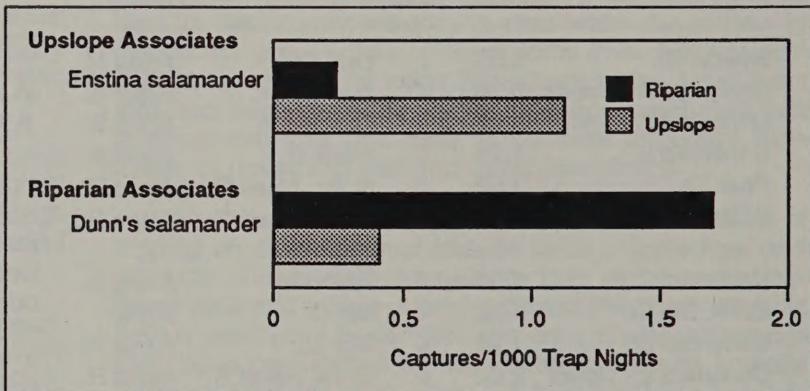

Figure 2. Comparison of amphibian captures along streamsides and upslope, Drift Creek Basin (from McComb et al. 1993).

Results

Small mammals

We captured a total of 18 species of small mammals; however, only six species had $\geq$ 30 captures and are considered in this analysis. Small mammal species diversity was higher on streamside transects than on upslope transects. Capture rates of marsh shrews, Pacific jumping mice, long-tailed voles, and white-footed voles were higher along streamside than upslope transects (Figure 1). Capture rates for western red-backed voles, creeping voles, Trowbridge's shrews, and Townsend's chipmunks were higher along upslope than streamside transects. There were no differences in pattern of captures (upslope vs. riparian) between dry and wet seasons, but capture rates were considerably lower for most species during the dry season than during the wet season.

Amphibians

Nine species of amphibians were captured, two of which were captured on $\geq$ 30 occasions. Amphibian species diversity did not differ between streamside and upslope transects. Although some amphibian species require streams or ponds for reproduction, total amphibian captures were not associated with streamside habitat. More Dunn's salamanders were caught along streamside than upslope transects; whereas more ensatinas were caught along upslope than streamside transects (Figure 2). There were no differences in patterns of capture (upslope vs. riparian) between dry and wet seasons, but, similar to captures of mammals, capture rates for amphibians were considerably lower for most species (except tailed frogs) during the dry season than during the wet season.

Discussion

In contrast to our findings for birds and the results of the amphibian trapping, mammalian species diversity was somewhat greater along streamsides than in upslope environments. However, similar to our findings for birds, neither streamside nor upslope habitats alone seemed to provide adequate habitat for all of the small mammal or amphibian species that we sampled.

For managers interested in maintaining regional biodiversity and providing habitat for a diverse assemblage of wildlife species, these results highlight the importance of considering both upslope and riparian habitats. A strong focus of wildlife management efforts on riparian areas with less regard for uplands is inadequate.

It has been widely assumed that streamside areas provide habitat for more terrestrial vertebrates than other habitats. Our results suggest that this assumption may not be true for amphibians and diurnal birds along second- and third-order streams in mature forests; riparian management alone may not meet the needs of vertebrates of mature forest stands of the central Oregon Coast Range. A landscape-level approach that considers both upslope habitat and riparian habitat simultaneously may be more effective.

Land managers may wish to consider expanding riparian corridor width to include optimal habitat for species associated with mature forests and upslope areas, although further research is necessary to determine the appropriate corridor width for each species. Alternatively, upslope corridors of mature forest could be maintained and intervening managed forest stands could be made more permeable to these species by retaining significant amounts of within-stand structure (e.g., snags, large conifers) during harvest. A coordinated network of upslope and streamside forest patches with permeable intervening stands may be the most effective overall strategy.

Suggested Readings

McComb, W.C., R.G. Anthony, and K. McGarigal. 1991. Differential vulnerability of small mammals to two trap types and two trap baits. Northwest Science 65:109-115.

McComb W.C., K. McGarigal, and R.G. Anthony. 1993. Small mammal and amphibian abundance in streamside and upslope habitats of mature Douglas-fir stands, western Oregon. Northwest Science 67:7-15.

McGarigal, K., and W.C. McComb. 1992. Streamside versus upslope associations of breeding birds. COPE Report 5(4):4-6.

McGarigal, K., and W.C. McComb. 1992. Streamside versus upslope bird communities in the central Oregon Coast Range. Journal of Wildlife Management 56:10-23.

Oakley, A.L., J.A. Collins, L.B. Everson, D.A. Heller, J.C. Howerton, and R.E. Vincent. 1985. Riparian zones and fresh-water wetlands. Pages 57-80 in Management of Wildlife and Fish Habitats in Forests of Western Oregon and Washington. E.R. Brown, tech. ed. USDA Forest Service, Pacific Northwest Region, Portland, Oregon. Publication No. R6-F&WL-192-1985.

Kevin McGarigal and William C. McComb,
OSU Forest Science Department

OPPORTUNITIES

From the OSU College of Forestry Conference Office:

COMMERCIAL THINNING & UNDERPLANTING TO ENHANCE DIVERSITY OF FORESTS & STREAMS

April 22, 1993 — Mapleton, OR

Managers and researchers have joined forces to install new experiments in order to gain much-needed information about ecosystem management. New studies have been installed promoting structural diversity in upslope and riparian forests. This field forum is an opportunity to see these experiments in an early stage and discuss the underlying issues, assumptions, experimental techniques, and management implications. The program will begin with an orientation to management on the Siuslaw National Forest and a brief overview of ecosystem management concepts. The last stop will focus on riparian zone and stream enhancement for fish habitat.

This field forum should appeal to wildlife biologists, resource managers, small woodland owners, silviculturists, loggers, foresters, and anyone interested in habitat enhancement for fish and wildlife.

This workshop will also be offered at a future date because of popular demand.

TIMBER BRIDGE INSPECTION AND LOAD RATING ANALYSIS

April 27-29, 1993 — OSU

The purpose of this course is to update field engineers with the current AASHTO (American Association of State Highway Transportation Officials) procedures for timber bridge inspection and vehicle load rating analysis. Elementary bridge mechanics will be reviewed; AASHTO vehicle load-rating analysis procedures will be covered in detail. A field inspection of a timber bridge will be made and an AASHTO vehicle load rating performed on the structure.

SILVICULTURE INSTITUTE: MODEL 5—REGENERATION AND STAND MANAGEMENT

May 3-14, 1993 — OSU

The classwork in this module focuses on incorporating the biological and economic concepts covered in prior

modules into a framework that can be used to assess and solve operational forestry problems in reforestation and intermediate stand management. Teaching includes lectures, field trips and small group exercises.

WORKSHOP ON HIGH QUALITY FORESTRY

May 11-25, 1993 Silver Falls, Oregon

This workshop is designed to explore the idea of managing forests in the Northwest on long-rotations (150-200 years) to improve the quality of wildlife habitat and wood products. The objective for this workshop is to review the current state-of-knowledge on this subject, to document this information in a single source (conference book), and to investigate and prioritize the needed research and development in this area.

NOTE: This workshop is already full. To register on a waiting list for a repeat workshop, contact Cindy Miner, USDA Pacific Northwest Experiment Station, Continuing Education, P.O. Box 3890, Portland, OR 97208-3890, or Telephone (503) 326-7135, FAX: (503) 326-2455

SAWING TECHNOLOGY

June 5, 1993 OSU

This is a one-day workshop to provide state-of-the-art information relating to saws and sawing technology for sawmill managers, superintendents, filing supervisors and filers.

SILVICULTURE INSTITUTE: MODEL 6— A Case Study of Silvicultural Problem Solving

June 21-July 2, 1993 UW Pack Forest, Washington

The emphasis of this module is the development, in small groups, of a case study for dealing with a silvicultural problem to meet a given specific stand management goal. The project incorporates all of the material presented in the Institute and is assessed in the field by a panel of experts.

UNEVEN-AGED METHODS FOR ECOSYSTEM MANAGEMENT: FOREST HEALTH, FIRE, WILDLIFE

June 22-24, 1993 Sisters, Oregon

This three-day workshop focusing on management of Northwestern interior forests with uneven-aged silvicultural techniques will be held in central Oregon in order to take advantage of the diversity of forest types and examples on the Deschutes National Forest.

Instruction will be one-third formal lecture, and two-thirds field trips, with exercises and discussions, in ponderosa pine and mixed conifer forests. The subject material will include basic applications and interpretations applicable to any forest ecosystem.

This workshop is co-sponsored by the Society of American Foresters, Oregon Chapter and Silvicultural Working Group, the USDA Forest Service and Oregon State University College of Forestry.

For more information on the above mentioned workshops, contact the Forestry Conference Office, Oregon State University, Peavy Hall 202, Corvallis, OR 97331-5707, or Telephone (503) 737-2329, FAX: (503) 737-2668.

RECENT PUBLICATIONS

AMPHIBIAN BIODIVERSITY OF THE PACIFIC NORTHWEST WITH SPECIAL REFERENCE TO OLD-GROWTH STANDS by Susan C. Walls, Andrew R. Blaustein, and Joseph J. Beatty. 1992. Northwest Environmental Journal 8:53-69. In recent years, many species of amphibians have apparently undergone population declines and range reductions in various parts of the world for reasons that remain elusive. The Pacific Northwest has a unique amphibian fauna that contains several species that occur nowhere else. Five species are candidates for protection under the federal endangered species act. This paper describes the diversity of amphibians in the Pacific Northwest, summarizes information concerning the habitat relationships of several species, and examines the potential impacts of timber harvest on amphibian species with an emphasis on the impacts of logging in late seral stage forests. Almost three-quarters of the amphibians in the Pacific Northwest are forest-dwellers, and 60 percent of these require bodies of water for breeding. Most of the salamanders and half of the frogs and toads have distributions that are correlated with older forest ecosystems. According to this paper, most Pacific Northwest species of salamander and the tailed-frog would be threatened by harvest of substantial amounts of old-growth forests. The paper emphasizes the importance of maintaining suitable habitat for amphibians around wetlands, ponds, and streams in forest ecosystems.

JPH

BEAVER DAM LOCATIONS AND THEIR EFFECTS ON DISTRIBUTION AND ABUNDANCE OF COHO SALMON FRY IN TWO COASTAL OREGON STREAMS by Karen Leidholt-Bruner, David E. Hibbs, and William C. McComb. 1992.

Northwest Science 66:218-223. Attempts to provide habitat for salmonid fish has greatly influenced the management of drainages in the Coast Range. Special emphasis has been placed on providing suitable spawning and rearing habitat by maintaining or enhancing stream structures, but stream enhancement can be an expensive venture. Beaver dams may provide an alternative to engineered stream improvements in some situations. Prior to this study, the value of beaver dams to salmonids in the Oregon Coast Range was not clear; beaver dams create pools which may be beneficial to salmonids, but they may also be barriers to fish movement. The results of this COPE funded study demonstrate that pools created by beaver dams in Coast Range streams increased pool habitat 7 to 14 percent in the streams examined. Density of coho salmon (number of fish per m^2 or m^3 of pool) was similar between beaver ponds and non-beaver created pools, but beaver ponds tended to be larger than non-beaver created pools and thus supported more fry. Beaver dams are ephemeral and are often destroyed by winter flows, but dams are not always washed away completely and remnants of the dam may provide some slow-water refuge for salmonids. The authors conclude that maintaining high beaver densities in coastal streams may be a beneficial strategy for managing salmonid spawning and rearing habitat in some areas.

JPH

<u>SEASONAL CHANGES IN HABITAT USE BY JUVENILE COHO SALMON (*Oncorhynchus kisutch*) IN OREGON COASTAL STREAMS</u> by Thomas E. Nickelson, Jeffrey D. Rodgers, Steven L. Johnson, and Mario F. Solazzi. 1992. Canadian Journal of Fisheries and Aquatic Sciences 46:783-789. Habitat use by juvenile coho salmon during spring, summer, and winter was examined in Oregon coastal streams. The study ranged from the Nehalem River basin in the north to the Coquille River on the south coast. Coho salmon fry were most abundant in backwater pools during spring. During summer, juvenile coho salmon were more abundant in pools of all types than they were in glides or riffles. During winter, juvenile coho salmon were most abundant in alcoves and beaver ponds. Because of the apparent strong preference for alcove and beaver pond habitat during winter and the rarity of that habitat in coastal streams, the authors concluded that if spawning escapement is adequate, the production of wild coho salmon smolts in most spawning steams on the Oregon Coast is probably limited by the availability of adequate winter habitat. If this conclusion is true, it would be difficult to reliably determine the habitat limiting production from only a summer habitat inventory, which is the common practice today.

DSB

<u>EVALUATION OF PREDICTION MODELS AND CHARACTERIZATION OF STREAM TEMPERATURE REGIMES IN WASHINGTON</u> by K. Sullivan, J. Tooley, K. Doughty, J.E. Caldwell, and P. Knudsen. 1990. Timber/Fish/Wildlife Rep. No. TFW-WQ3-90-006. Washington Department of Natural Resources, Olympia, Washington. 224 pp.

A Timber-Fish-Wildlife (TFW) Temperature Work Group (TWG) studied stream temperature and temperature prediction models with data collected from more than 75 streams in Washington during the summer of 1988. The study evaluated stream temperature prediction models to determine the best model for use by forest land managers in Washington. The TWG also established stream temperature regime regions within the state, assessed the effects of riparian area management on stream temperature within these regions, and determined stream characteristics that indicate which streams within each region might be temperature sensitive.

Both stream reach and basin-level models were evaluated by the TWG. The reach models evaluated were TEMPEST, TEMP-86, Brown's Model, and SSTEMP. Each was given an overall rating that was weighted 40 percent for performance, 35 percent for practicality, and 25 percent for reliability. Model performance was evaluated by predicting stream temperature for 33 sites for which 40 days of stream temperature data were available. The model performance rating included consideration of the model's accuracy, precision, consistency, and bias. The reliability of the models was rated according to model sensitivity to input parameter variability, availability, and measurability. The evaluation of practicality included the cost and user-friendliness of the models. Although all models scored well in at least one rating category, TEMPEST was recommended as the best stream temperature prediction model for TFW applications by the TWG because of high ratings for performance and practicality.

The basin-level stream temperature prediction models evaluated were QUAL2E, SNTEMP, and MODEL-Y. The TWG concluded that the performance, reliability, and practicality of each of these models were insufficient to recommend their use for situations other than experimental. MODEL-Y has the greatest potential for use because it is user-friendly, requires very little data, and it can iterate in relation to different riparian conditions. However, caution was advised for use of basin-level models in general, and for MODEL-Y in particular, because of poor reliability and performance and the inherent complexity of predicting stream temperatures on a basin level.

Finally, the TWG assessed stream temperatures in relation to Washington water quality standards. Relationships between riparian vegetation and elevation were used to determine stream temperature sensitivity to riparian area management. Streams less than 100 m elevation were the most dependent on shade. These low-elevation streams required significant shade to maintain stream temperatures in the moderate to low range.

ED

ERRATUM

Horvath, E. and G. Tucker. 1992. Active management of riparian zones for multiple resources: Second year results of conifer release study. <u>COPE Report</u> 5(4):2-4.

In Figure 4, the stippled bars actually depict seedling mortality resulting from rodent damage, and the solid bars depict seedling mortality resulting from competition and reduced light. The published legend for the figure was in error. We apologize for any confusion that this error may have caused.

COPE

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COPE Report

Coastal Oregon Productivity Enhancement Program

Promoting Integrated Management of Oregon's Coast Range Forests Through Research and Education

Volume 6, Number 2 July 1993

From the Program Manager

In this issue of the COPE Report we present updates on three studies. The first is an adaptive study titled "Commercial Thinning and Underplanting to Enhance Structural Diversity of Young Douglas-fir Stands in the Oregon Coast Range." This study examines the combined effects of different intensities of commercial thinning, and of underplanting with several conifer and hardwood species, on stand structural diversity. The intent is to develop silvicultural treatments that involve some timber harvest while enhancing wildlife habitat suitability. One replication has already been installed on the Mapleton District of the Siuslaw National Forest, and two more are planned for the Waldport and Hebo Districts. Justifiably, this study has attracted a lot of attention. There have already been two field trips to the Mapleton site and a third is planned for later this year.

The second study explores the association of stand age, and indirectly stand structure, with population levels of flying squirrels and chipmunks in the Coast Range. Both species are important to regional biodiversity, the energy flow in forest ecosystems, and the dispersal of mycorrhizal-forming fungal spores. Preliminary data show some interesting results. For example, one young stand had a high capture rate for flying squirrels while other stands of similar age had much lower capture rates. Additional trapping data and vegetation analysis should provide insight into the habitat associations of these species.

The third study update provides an innovative look at how fish communities respond to increased habitat structural complexity and food availability. "Influence of Habitat Complexity and Food Availability on the Fish Community in an Oregon Coastal Stream" is part of the larger fundamental COPE study "Fish Habitat and Riparian Zone Interactions."

A theme common to these studies is habitat structural complexity or diversity. Understanding how spatial and temporal differences in habitat structure, at the stand, basin, and landscape level, affect multiple forest values is essential to successful ecosystem or integrated forest management.

Steve Hobbs

IN THIS ISSUE

COPE Report

This issue of the COPE Report was prepared by Gretchen Bracher, Skye Etessami, John Hayes, Kathleen Maas, Arne Skaugset, Judy Starnes, and Gabe Tucker. The COPE Report is produced quarterly as a contribution of Adaptive COPE. Because of space limitations, articles appear as extended abstracts. Results and conclusions may be based on preliminary data or analysis. Readers interested in learning more about a study should contact the principal investigator or wait for formal publication of more complete results. Comments and suggestions concerning the content of the COPE Report are welcomed and encouraged. To receive this free newsletter, or for information about Adaptive COPE, contact Adaptive COPE, 2030 S. Marine Science Dr., Newport, OR 97365, (503) 867-0220. For specifics on the overall COPE Program, contact Steve Hobbs, COPE Program Manager, Forestry Sciences Laboratory, 3200 SW Jefferson Way, Corvallis, OR 97331, (503) 750-7426.

The COPE Program is a cooperative effort between Oregon State University's College of Forestry, the USDA Forest Service, Pacific Northwest Research Station, the USDI Bureau of Land Management, other federal and state agencies, forest industry, county governments, and the Oregon Small Woodland Association. The intent of the program is to provide resource managers and the public with information relative to the issues and opportunities associated with the management of fish, timber, water, wildlife, and other resources of the Oregon Coast Range. The COPE Program emphasizes an integrated approach—an integration of research and education and an integration of scientific disciplines—to find effective ways to manage these diverse resources collectively.

The COPE Program has two related components: Fundamental COPE and Adaptive COPE. Comprised of OSU and PNW scientists based primarily in Corvallis, Fundamental COPE addresses problems related to riparian zone management and reforestation in the Coast Range through basic research. Adaptive COPE is comprised of an interdisciplinary team responsible for applying and adapting new and existing research information to solve specific management problems. Stationed on the coast in Newport at the Hatfield Marine Science Center, the Adaptive COPE team is also responsible for providing continuing education opportunities to facilitate technology transfer.

ADAPTIVE COPE

COMMERCIAL THINNING AND UNDERPLANTING TO ENHANCE STRUCTURAL DIVERSITY OF YOUNG DOUGLAS-FIR STANDS IN THE OREGON COAST RANGE

Introduction

Logging activities over the past few decades in the Oregon Coast Range have resulted in hundreds of thousands of acres of young Douglas-fir plantations. Conversion of natural forests to intensively managed plantations has traditionally been a primary objective of timber management. New information and new issues have surfaced, however, and alternative approaches to forest management are being considered in order to maintain regional biodiversity and the health and long-term productivity of forest ecosystems in the Oregon Coast Range.

Wildlife biologists and forest ecologists are learning more about the relationships between wildlife, landscape patterns, stand structure, and forest ecosystem functions. Although specific structural characteristics required are unknown for several wildlife species, structural patterns found in late seral stage and old-growth forests appear to be preferred by some species, including the northern spotted owl.

The National Forests in the Northwest are currently managing forest lands for spotted owls according to the guidelines developed by the Interagency Scientific Committee (ISC) that was appointed to develop a conservation strategy for the species. The ISC strategy prompted the creation of Habitat Conservation Areas (HCA's); logging currently is not allowed in HCA's. There are 90,000 to 100,000 acres of young managed stands on the Siuslaw National Forest that are in HCA's. The ISC strategy allows for vegetation management within HCA's to enhance owl habitat, but only after the efficacy of techniques are demonstrated outside of HCA's.

Objectives

Present research suggests that young stands may develop some characteristics typical of old-growth habitat more rapidly if intensively managed. This management involves thinning young stands to low densities, stimulating rapid growth of dominant trees and allowing development of understory trees. Currently, the paucity of growth and yield data for trees in stands managed in this way limits the ability of forest ecologists to accurately project the development of such stands over time. This project will establish and monitor an array of stand density management regimes

designed to develop multi-storied stands. Information gathered from these stands will fill in the gaps in our knowledge base.

The structural characteristics of forest stands can vary widely among stands of a given age. Stand basal area, trees per acre, canopy density, species composition, and the contribution of different crown classes of trees can be vastly different, even though the stands in question may have been established at exactly the same time. Through silvicultural manipulation, practically all the characteristics of stand structure can be modified. This modification can be done relatively rapidly if the stand is already established but is still young.

The primary objective of this study is to determine how land managers in the Oregon Coast Range can enhance structural diversity and sustain productivity of a wide range of resources in young Douglas-fir forests of high site index. Secondary objectives will address specific hypotheses concerned with many ecosystem parameters including understory vegetation, microclimate, and wildlife habitat suitability. For example, an important secondary objective will be to assess whether or not other measures, such as canopy height diversity (see article by Spies and Cohen, COPE Report 5(3):5-7), are adequate for assessing certain types of wildlife habitat suitability.

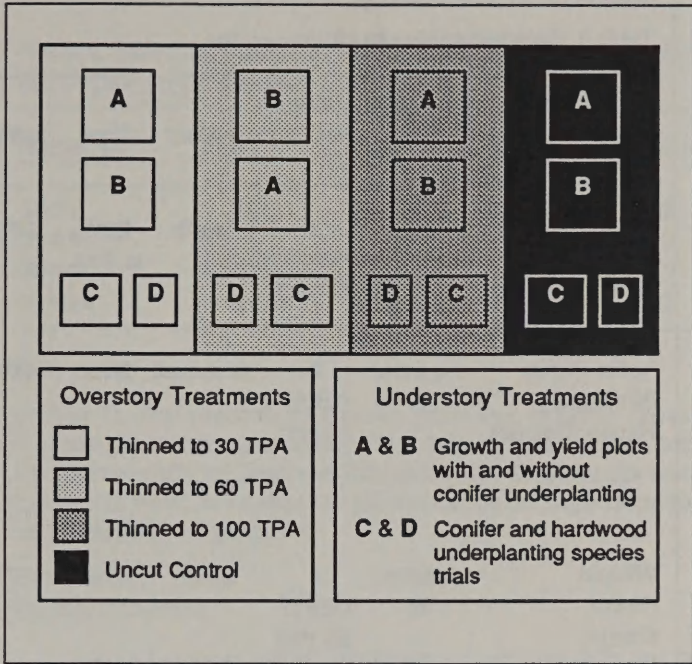

Figure 1. Schematic showing the treatments applied in this study. In the field, the relative locations of the overstory and understory treatments were assigned randomly.

Approach

Our approach is to thin young (20-40 yr) plantations to a variety of densities: standard (100 tpa), wide (60 tpa), and very wide (30 tpa) (see Figure 1). Other stands will be left unthinned as controls (200-400 tpa). In addition, we are planting alder, hemlock, and Douglas-fir in some parts of the understory in an attempt to enhance understory development and to develop vertical structure. The development of vertical structural diversity of underplanted and unplanted areas will be compared. Several other species, including bigleaf maple and Pacific yew, will also be planted in species trials under each overstory treatment. We hypothesize that these combinations of overstory density and understory management will provide a wide array of vertical structures at various time intervals, and that some of these silvicultural prescriptions will provide old-growth-like habitat in a much shorter time frame than the unthinned (control) stands. All of the manipulations in question are being done at commercial thinning age so that the operations will be economically viable.

Stand structure and canopy dynamics, including leaf area and crown development, will be monitored periodically throughout the life of the project to assess the development of canopy structure. Growth and yield of merchantable timber will also be tracked on growth and yield plots. Trees that are 20-40 years old have fairly well developed crowns and are still capable of responding rapidly to thinning. The response of understory vegetation will also be tracked both from the perspective of wildlife habitat and the establishment of understory conifers. The mosaic of microsites that develop under the different stand densities are important drivers that affect change in the understory vegetation, wildlife habitat, and, stand succession. This portion of the study is being completed through close collaboration with scientists at the USDA Forest Service's Pacific Northwest Research Station.

The influence of changes in forest structure that result from the experimental treatments will be quantified to assess their influence on wildlife habitat. Because of the small size of the study areas, assessments of wildlife use will be qualitative. In other words, we can quantify changes in the physical habitat, but the area is not big enough to get reliable quantitative estimates of animal use. The wildlife assessment will, therefore, rely heavily on results from other COPE studies, including projects that have been completed, are in progress, and are being planned for the coming years.

Three study sites have been selected from Oregon Coast Range forests to encompass a broad range of site conditions such as slope, aspect, and plant association. These sites are within the western hemlock vegetation series and are comprised of planted Douglas-fir stands approaching stand densities that need thinning (RD 45 to 55). Such stands range in age from 30 to 40 years (Table 1).

Progress to Date

Through close collaboration between Adaptive COPE, the Siuslaw National Forest, the OSU College of Forestry, and the USDA Forest Service's Pacific Northwest Research Station, a great deal of work has already been accomplished on this

Table 1. Selected study site characteristics.

Site	Size (ac)	Site index	Aspect	Slope	Latitude	Soil	Vegetation[1]	Mean DBH	Harvest date	Age
Cataract Creek (Mapleton Ranger District)	28	I (154'/[2] 50 yrs)	North	20% to 60%	44° 05'	Preacher-Bohannon Slick Rock Series	Tshe/Acci and Tshe/Rusp	10.9"	10/92 to 12/92	30
Keller Creek (Waldport Ranger District)	Approx. 40	II (160'/[3] 50 yrs)	Northeast	30%	44°17'	Astoria Silt Loam Series and Preacher-Bohannon Slick Rock Series	Tshe/Pomu and Tshe/Gast	12.9"	Fall '93	33
Wildcat (Hebo Ranger District)	Approx. 35	I (125'/[2] 50 yrs)	South	40%	45°19'	Typic Haplohumults	Pisi/Rusp	12.0"	Fall '93	33

[1] "Plant Association Guide Siuslaw National Forest"

[2] King Site Index Curves

[3] McArdle Site Index Curves

project. One site (on the Mapleton Ranger District) has been fully installed, pretreatment data have been collected, and the area has been logged and underplanted. The other two sites (near Hebo and Waldport) have been laid out and pretreatment data collection is under way. They will be logged this fall. Two day-long field forums highlighting the project have been held to capacity crowds, and a third is planned for this fall in collaboration with the Western Forestry and Conservation Association.

Conclusion

This study will demonstrate whether stands can be partially harvested and managed to create habitat for wildlife species that are associated with old-growth or late-successional forests. It should also provide key information that will enable forest managers to move towards an ecosystem approach to management that focuses on sustaining processes that keep ecological systems diverse, healthy, and productive. This study will provide basic information for any landowner who wishes to manage stands with increased structural diversity.

Gabe Tucker,
Adaptive COPE
Bill Emmingham,
OSU Forest Science Department
Stu Johnston,
Siuslaw National Forest

FLYING SQUIRREL AND CHIPMUNK POPULATIONS IN YOUNG PLANTATIONS: Preliminary results from the fall, 1992 trapping session

Introduction

Recent studies, several of them funded by the COPE program, have made substantial progress toward clarifying the influence of habitat structure and various forest management practices on wildlife populations in the Oregon Coast Range. These studies have shown that different wildlife species exhibit varying degrees of sensitivity to changes in forest structure. Northern flying squirrels may be particularly sensitive to forest structure. Although there is some evidence that flying squirrels are closely associated with late seral-stage forests, the association between flying squirrels and stand age is not fully resolved.

Flying squirrels are an important element in regional biodiversity, play a critical role in energy flow in Oregon Coast Range forests, and are important in dispersal of the spores of mycorrhizal fungi. In addition, flying squirrels are the primary prey species of the northern spotted owl in much of western Oregon and Washington. Although recently there have been a number of studies concerning the habitat relationships of flying squirrels in Oregon (see Sug-

gested Readings), gaps remain in our knowledge base that hinder the development of informed management programs that take flying squirrels into account.

The Townsend's chipmunk is a dominant species in many small mammal communities in western Oregon. Like the flying squirrel, it plays an important role in forest ecology; it is an important prey species for diurnal predators and a key disperser of mycorrhizal fungal spores. Despite the relative importance and abundance of this species in Oregon Coast Range forests, surprisingly little is known about the habitat relationships of the species.

In this report, we summarize trapping results for the first field season of a study that examines the habitat associations of flying squirrels and chipmunks in the Oregon Coast Range. Additional trapping will be conducted in spring, 1993.

Methods

We examined flying squirrel and chipmunk population abundances in three areas on the Waldport District of the Siuslaw National Forest. In each area, one stand was selected in each of four age classes for a total of 12 stands. The age classes examined were 10- to 15-, 20- to 25-, and 30- to 35-year-old Douglas-fir plantations, and mature, naturally-regenerated forests. In each stand we established grids of 32 stations (4 x 8) with 40 m between each station. We set two Tomahawk live-traps at each station: one on the ground and one 1.5 m above the ground in a tree. Traps were baited and checked daily for 8 consecutive days. During a given 8-day period, one stand of each age class was trapped. All chipmunks and flying squirrels captured were individually marked and released at the site of capture.

Sizes of chipmunk populations were estimated with the CAPTURE computer software package. To determine chipmunk densities, the effective area trapped was estimated by adding a buffer around the trapping grid equaling one-half the mean maximum distance moved. Population densities were estimated by dividing the population estimate by the effective area trapped. Because of the low number of recaptures of flying squirrels, it was not possible to estimate population size. Instead, we used number of captures per unit effort, which in this case was the number of individuals per 100 trap-nights (a trap-night is one trap set for one night), as an index of the relative abundance of flying squirrels.

Vegetative characteristics of the stands are in the process of being measured and analyzed.

Results and Discussion

Chipmunks

There was considerable variation in chipmunk densities among the 12 sites examined, and these differences were not closely associated with stand age. Estimated chipmunk densities ranged from 0 per hectare to 23.8 per hectare (Table 1). The maximum density from our study is almost 3 times greater than that reported from similar studies conducted recently in Cascade Range forests. Chipmunks were generally most abundant in stands that had high densities of understory vegetation.

Table 1. Estimated number of Townsend chipmunks per hectare in each of the trapping areas.

Stand age	Area 1	Area 2	Area 3	Average
10-15	5.3	11.6	22.8	13.2
20-25	6.7	9.3	0	5.3
30-35	5.3	17.4	10.1	10.9
mature	10.0	23.8	5.7	13.2

Flying squirrels

Flying squirrels were captured in all stands over 20 years of age and in one of the 10-year-old plantations (Table 2). Trap success for flying squirrels from our first trapping session was typical of the trap success reported from other studies conducted in the Pacific Northwest. Overall capture success was extremely low in the youngest forest stands examined (an average of 0.1 individuals per 100 trap-nights), suggesting that forest stands of this age provide extremely poor habitat for flying squirrels. Among other age classes there was considerable variation in capture success. Although greater numbers of flying squirrels were typically captured in mature stands than in plantations, we had high capture success in one of the 20- to 25-year-old sites (in area 2). Measurements of habitat characteristics have not yet been completed; we are hopeful that differences in characteristics of the vegetation will explain some of the differences in trap success among stands.

Our preliminary results for flying squirrels suggest that, although mature forest stands provide good habitat for flying squirrels, in some cases younger stands may also provide good flying squirrel habitat. Stand age is often correlated with several habitat characteristics to which some wildlife species respond. For example, late successional forests generally have high densities of large logs on the forest floor, an important habitat component for several species of mammals and amphibians. But stand age in and of itself is not a characteristic of habitat to which wildlife respond,

Table 2. Number of individual flying squirrels captured per 100 trap-nights in each of the trapped areas.

Stand age	Area 1	Area 2	Area 3	Average
10-15	0	0.2	0	0.1
20-25	0.2	1.8	0.4	0.8
30-35	0.8	0.6	0.2	0.5
mature	1.6	0.6	2.0	1.4

although in some cases the necessary complement of habitat components required by particular species may be present only in certain age stands. Our preliminary results suggest that the necessary habitat components to support healthy populations of flying squirrels in the Oregon Coast Range are generally present in late seral stage forests and are sometimes, but not always, present in young forests.

If our preliminary results hold up to additional study and scrutiny, they have implications for the management of spotted owls. For an area to meet the foraging requirements of spotted owls, two criteria must be met. First, prey must be present in the area in adequate numbers to support owls. Second, the habitat structure of the area must be conducive to hunting by spotted owls. Our data suggest that the first component of foraging habitat for spotted owls is sometimes met in young forest stands. While mature forest stands generally had higher populations of flying squirrels then did younger stands, one 20- to 25-year-old stand had a similar number of flying squirrels as did the mature stands. However, a substantial data base collected from studies throughout western Oregon and Washington has demonstrated that spotted owls exhibit a strong preference for late-seral stage forests for nesting as well as for foraging habitat.

Two scenarios, which are not mutually exclusive, may account for these findings. First, although flying squirrels may be abundant in some young forest stands, their low abundance in many young stands make flying squirrels an unreliable food source in young forest stands. Flying squirrels were abundant in only one of the nine young forest stands examined. Extensive foraging in young forest stands may be a poor investment of time for spotted owls because of the relatively low probability of finding younger stands with high flying squirrel populations. Alternatively, although the prey base in young forest stands may at times be adequate for spotted owls, the habitat structure of young forest stands may structurally impede foraging by spotted owls. More open stands with greater structural diversity may be necessary to provide spotted owls with suitable foraging habitat. If this is the case, restoration and silvicultural activities in young forest stands, such as discussed in the preceding article, may accelerate the development of the stand structural needs of spotted owls; the value and feasibility of restoration activities to provide this habitat need further study.

Suggested Readings

Carey, A.B., B.L. Biswell, and J.W. Witt. 1991. Methods for measuring populations of arboreal rodents. USDA Forest Service, Pacific Northwest Research Station, Portland, Oregon. General Technical Report PNW-GTR-273.

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Rosenberg, D.K., and R.G. Anthony. 1992. Characteristics of northern flying squirrel populations in young second- and old-growth forests in western Oregon. Canadian Journal of Zoology 70:161-166.

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INFLUENCE OF HABITAT COMPLEXITY AND FOOD AVAILABILITY ON THE FISH COMMUNITY IN AN OREGON COASTAL STREAM.

Introduction

In recent years, fisheries scientists in the Pacific Northwest have investigated factors that limit fish populations in streams. Most of this research has focused on single species of fish and has not considered the entire fish community in streams. In addition, much of the research has characterized only the physical habitat of the fish. At the same time, the number of stream enhancement or restoration projects in Pacific Northwest streams has been increasing; the objective of most of this work is to improve fish habitat. Most restoration or enhancement projects are carried out with little or no experimental design or subsequent evaluation.

We have designed and initiated an experiment to determine the effects of two factors structuring the fish community in a coastal Oregon stream. These factors are food availability and the structural complexity of the large woody debris (LWD) in the stream. The study objectives are (1) to determine the effect of structural complexity (using LWD) on fish biomass, (2) to determine the effect of food availability on fish biomass, and (3) to determine if there is an interaction between food availability and structural complexity.

Methods

This study is being conducted on a 2.5 km reach of Camp Creek, a fourth-order stream in the Alsea River basin in the Oregon Coast Range. We selected 32 pools in Camp Creek that have maximum depths greater than 0.4 m, surface areas greater than 75 m^2, low LWD loadings, and low numbers of boulders. Eight blocks, each containing four experimental pools, were established beginning at the downstream end of the stream. Within each block the pools were randomly assigned one of four structural complexity treatments. The treatments are an untreated control, a low complexity treatment with two large logs, a medium complexity treatment with three large logs and two tree tops, and a high complexity treatment with five large logs and five tree tops. All the logs were Douglas-fir and the tops were either maple or alder.

The treatments were installed in September, 1991 in a cooperative project with the Alsea Ranger District of the Siuslaw National Forest. A hydraulic excavator was used to position the logs and tops to provide structural complexity only and not to modify the original pool morphology. All treatments were standardized for experimental purposes; thus, the project did not take advantage of habitat features that might have been emphasized by normal rehabilitation efforts by the Forest Service. Fish species present in Camp Creek included coho salmon, cutthroat trout, steelhead trout, speckled dace, and two species of sculpins (*Cottus perplexus* and *C. gulosus*).

In June, 1992 the fish community was sampled using pass-removal electroshocking to determine the distribution and abundance of all fish species. The captured fish were identified by species and weighed, the fork lengths (length from snout to fork of tail) were measured, and the fish were then released back into the pool from which they were captured. Salmonids were tagged with liquid nitrogen freeze-branding. Fish biomass data (by species) have been analyzed using an analysis of variance for a randomized block design.

In July, 1992 half of the blocks were randomly selected to receive a feeding treatment. Selected pools received 25 grams of freeze-dried krill per day, 6 days a week for 6 weeks. In an effort to mimic invertebrate drift, the krill were presoaked for 12 hours and released into the stream just above the treatment pools. After the 6-week treatment period, the pools were resampled by pass-removal electroshocking. All fish were again identified by species and weighed, fork length was measured, and captured salmonids were checked for tags. Fish biomass data were analyzed using analysis of variance for a split-plot design. Growth rates were calculated for fish recaptured in their original pool.

Results

June

Salmonids comprised approximately 40 percent of the fish community biomass, with dace and sculpins accounting for approximately 15 and 45 percent, respectively (Figure 1). Total fish biomass was greater in pools with increased levels of structural complexity (Figure 2). Cutthroat trout biomass was higher in all treatments than in controls, but no differences were detected in biomass of coho, dace, or sculpin.

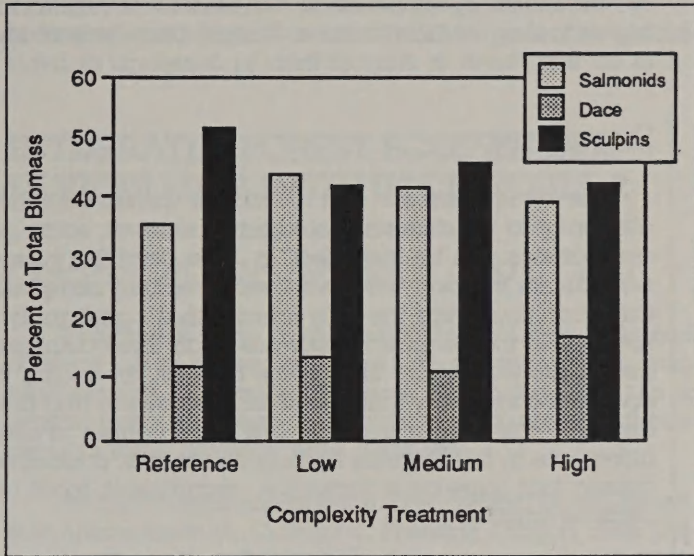

Figure 1. Composition of Camp Creek fish community by percent biomass for different treatment levels June, 1992.

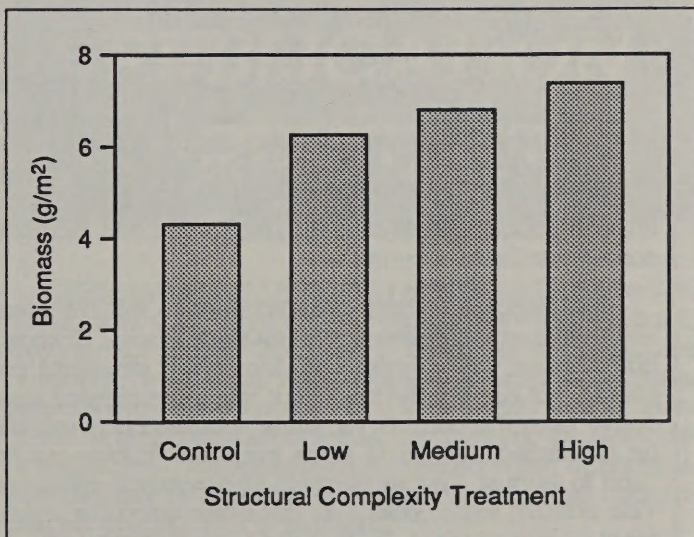

Figure 2. Mean biomass of all fish species by structural complexity treatment for Camp Creek for June, 1992.

August

Analysis of the data collected in August is still underway, however some trends can be identified. Salmonids comprised approximately 30 percent of the fish biomass with dace and sculpins accounting for approximately 50

and 20 percent, respectively. Preliminary results indicate that a potential interaction between structural complexity and food availability influences total fish biomass. Biomass and growth rates of juvenile coho in pools supplemented with food were significantly higher than in control pools. No differences in the biomass of cutthroat, dace, and sculpins in food-supplemented and control pools were detected. In all treatments, speckled dace densities were substantially higher in August than in June. Sculpin biomass was lower in all treatments in August than in June.

Summary

The results indicate that individual species responded differently to the different treatments; however, some general patterns can be identified. In June, total fish biomass was greater in pools with increased structural complexity. Cutthroat trout were the only species that significantly responded to the treatments. Biomass in all three complexity treatments was higher than in the controls, indicating that structural complexity influenced fish distribution and abundance in this stream in June. We were unable to detect differences in fish biomass among treatments, a result suggesting that some other factor (i.e., recruitment, food) may become limiting.

Results of unpublished studies indicate that cutthroat biomass is greater with increasing structural complexity during winter. Cutthroat distribution and abundance may be tightly linked to LWD structural complexity across seasons. Cutthroat response in all treatments in August was highly variable, indicating that other factors may influence its distribution.

Coho biomass did not appear to be associated with the structural complexity treatment level in June. Recent work by the Oregon Department of Fish and Wildlife indicates structural complexity may be more important to coho during winter. The feeding experiment indicates that food is an important factor influencing the distribution and biomass of coho juveniles in summer.

The response of dace and sculpins to the complexity treatments was consistent, but not pronounced. Biomass of both species was greater with increasing structural complexity, but none of the treatment responses differed significantly from the controls for either species. Dace exhibited an interesting pattern of large increases in biomass from June to August. Further analysis and research should provide possible explanations for this observation (i.e., recruitment or immigration). Further data analysis may also provide an explanation for the decrease in sculpin biomass from June to August.

The full response of the fish community to the LWD treatments may have a lag time. As a consequence, we believe additional valuable information will be obtained with continued monitoring. Furthermore, some benefits of the LWD introductions such as increased organic matter retention and refuge for organisms during floods may become more pronounced through time. Restoration of stream ecosystems takes time and it is important to conduct rigorous long-term experiments to determine if these projects will bringing desired results.

Steve Fieth and Stan Gregory,
OSU Department of Fisheries & Wildlife

OPPORTUNITIES

From the OSU College of Forestry Conference Office:

FOREST HEALTH FIELD WORKSHOP

September 7-9, 1993 Santiam Pass, OR

This three-day workshop on maintaining forest health through silvicultural techniques is aimed at manipulating populations of insects, fungi, vertebrates, and vegetation. The workshop is designed for woodlands owners, forest and wildlife managers, and environmentalists.

GEOGRAPHIC INFORMATION SYSTEMS

September 22-23, 1993 OSU

The workshop develops a basic understanding of GIS systems and their capabilities. Emphasis is given to the contrast between traditional and digital maps. This workshop is designed as an introduction to GIS technology and computer-assisted map analysis. It is ideally suited for professionals who have had minimal exposure to GIS, but anticipate using the technology or interacting with GIS specialists. There are no prerequisites for the workshop; however, basic familiarity with office computers is recommended.

MINFORS II: MINORITIES IN FORESTRY

October 24-26, 1993 OSU

Minority Participation in Forestry and Forestry-Related Sciences: a Need, a Goal, a Commitment

This national symposium will change outmoded images of what today's forestry and forestry education is all about, and present clear information on the great variety of rewarding professional careers covering the broad spectrum of forestry and natural resources.

This program is directed toward college students and other young people of African-American, American Indian/Alaskan Native, Asian-American/Pacific Islander, or Hispanic backgrounds. Also encouraged to attend are college and high school counsellors, educators, recruiters and employers. Anyone seeking information about natural resource careers and the outlook for forestry and natural resources should attend.

For more information on the above conferences, contact OSU College of Forestry Conference Office, Oregon State University, Corvallis, OR 97331-5707, or Telephone (503) 737-2329, or FAX (503) 737-2668.

From Washington State University Conference Office:

CREATING A FORESTRY FOR THE 21ST CENTURY

August 23-26, 1993 Portland, OR

The purpose of this symposium is to help define the nature and direction of the changes sweeping the field of forestry. It is designed to be solution oriented. Over the 3 days, the symposium will bring together regional, national, and international experts to explore what kind of forestry recent knowledge might lead us to create in the coming decades. The program will cover a broad range of biological, social, economic, and political issues.

This symposium is co-sponsored by the Olympic Natural Resources Center at the University of Washington's College of Forest Resources, the Consortium for the Social Values of Natural Resources, the Cascade Center for Ecosystem Management, the USDA Forest Service's New Perspectives Program (PNW Station/Region 6), COPE, Oregon State University, and the Bureau of Land Management.

To receive registration information contact Washington State University Conferences and Institutes, 7612 Pioneer Way East, Puyallup, WA 98371-4998, or Telephone (206) 840-4575.

From the Silviculture Institute:

FOREST AUTECOLOGY: SILVICULTURE INSTITUTE MODULE 1

September 13-24, 1993 UW Pack Forest Eatonville, WA

Participants become reacquainted with the foundations of forest biology as they examine the physical and biological components of forest trees and their environment. Field trips to Mt. St. Helens, Pack Forest, and various research sites assist in meshing concepts with reality.

Presented by Oregon State University and the University of Washington, the Silviculture Institute is an intensive continuing education program for natural resource managers. While some modules emphasize silviculture, the techniques and concepts presented in all modules apply to a variety of natural resource decision makers. Participants come from a variety of forestry organizations and disciplines from throughout western North America. Persons interested in individual modules rather than the entire series are encouraged to apply.

INTEGRATED FOREST ECOSYSTEMS: SILVICULTURE INSTITUTE MODULE 2

October 25 - November 5, 1993 OSU

Participants learn to integrate physical and biological components of the environment with functional and structural aspects of forest ecosystems. A two-day field trip to central Oregon stresses the application of ecological concepts to forest management decisions.

For information and applications, contact Dr. Ed Jensen, Silviculture Institute, College of Forestry, Oregon State University, Corvallis, OR 97331, or Telephone (503) 737-2519.

PUBLICATION REVIEWS

<u>SEEDS OF WOODY PLANTS IN NORTH AMERICA</u> by J.A. Young and C.H. Young. 1992. Dioscorides Press, Portland, Oregon. 407 pages. This book is based on the invaluable out-of-print Agriculture Handbook 450. Information includes suitable growing conditions of native woody plants, identification and collection of seeds, and germination. Methods of vegetative propagation are presented when applicable. An extensive listing of literature citations for further information on propagation is included.

KGM

<u>REFORESTATION OF DRAINED BEAVER IMPOUNDMENTS</u> by A.E. Houston, E.R. Buckner, and J.C. Rennie. 1992. Southern Journal of Applied Forestry 16:151-155. This study suggests that artificial regeneration of hardwoods in drained beaver impoundments is quicker and more efficient than natural regeneration with less desirable successional plants. Study sites were drained by breaching dams. Overstory trees were absent at all sites. Bare root and containerized seedlings were planted 2 years after drainage. Three years

after planting, soil moisture and nutrients did not limit the growth of seedlings, but shading from competing vegetation was found to be a limiting factor. At the end of the third growing season, survival and growth of seedlings in plots subjected to first-year weed control were not significantly greater than survival and growth of seedlings from control plots. Close spacing of seedlings during planting resulted in earlier crown closer and decreased competition from other vegetation in this study.

KGM

A PRELIMINARY BIODIVERSITY CONSERVATION PLAN FOR THE OREGON COAST RANGE by Reed F. Noss. 1992. Coast Range Association, Newport, Oregon. 40 pages. This report outlines a proposal for managing the Oregon Coast Range with a primary emphasis on conservation of biodiversity. The plan is based on four primary objectives: (1) to create a system of protected areas representing all native ecosystems and seral stages, (2) to maintain viable populations of all native species, (3) to maintain ecological and evolutionary processes, and (4) to design a system that can maintain biodiversity in the face of both short-term and long-term disturbances.

Using data on the distribution of species and habitats gathered from several sources, Noss ranks sites throughout the Oregon Coast Range for their importance to regional biodiversity. He then groups these sites into a network of Class I Reserves, Class II Reserves, and Multiple-Use Buffer Zones and outlines his management recommendations for each of the three categories. Noss recommends that no logging of natural forests take place in any of the three management areas and that logging activities in managed stands in Class I and Class II reserves would be limited to thinning and restoration activities. More intensive forest management for wood fiber would be permitted in Multiple-Use Buffer Zones. Primary differences between Class I and Class II reserves are that more aggressive land acquisition programs by public agencies would be pursued in Class I Reserves and greater road and trail access would be allowed in Class II Reserves. In addition, hunting in Class I Reserves would be restricted to activities necessary to control herbivore damage, whereas recreational hunting would be allowed in Class II Reserves. The report provides a map of the Oregon Coast Range outlining the location of areas recommended for each of the management classes.

The report is available for a cost of $6.50 from The Coast Range Association, PO Box 148, Newport, OR 97365.

JPH

ROOSEVELT ELK SELECTION OF TEMPERATE RAIN FOREST SERAL STAGES IN WESTERN WASHINGTON by Greg L. Schroer, Kurt J. Jenkins, and Bruce B. Moorhead. 1993. Northwest Science 67(1):23-29. The results of a study of habitat selection by Roosevelt elk in unlogged, logged, and regenerating forests on the Olympic Peninsula in Washington are presented and discussed in this paper. Female elk of four different herds were radio-collared and located periodically from June 1986 through June 1987. The proportion of time elk spent in different habitat was compared to the availability of habitat types to ascertain patterns of habitat association. Patterns of habitat associations varied somewhat with season. Elk frequented valley floors in all seasons except winter; during the winter they were predominantly on an adjacent plateau. Elk selected mature deciduous forests during the spring, summer, and autumn, and old-age Sitka spruce forests during autumn and winter. During the winter, elk also selected 6- to 15-year-old clearcuts. Young clearcuts (1-5 years old) and even-aged stands from 16 to 150 years old were generally avoided throughout the year. The authors argue that extensive even-aged coniferous forests do not contain the interspersion of forage and cover areas necessary to maintain good habitat for elk. As an alternative to managing extensive tracts of forest using standard rotation times and even-aged management, the authors recommend that silvicultural alternatives be considered, including uneven-aged management and extended rotations, and that commercial thinning be used to improve and maintain patterns of forage and cover for elk.

JPH

THE RELATIONSHIP BETWEEN CAVITY-NESTING BIRDS AND SNAGS ON CLEARCUTS IN WESTERN OREGON by B. Schreiber and D.S. deCalesta. 1992. Forest Ecology and Management 50:299-316. Schreiber and deCalesta examined the relationship between the diversity and abundance of cavity-nesting bird species to the density and characteristics of snags in the Oregon Coast Range. They censused birds and snags in 13 clearcuts on the Alsea District of the Siuslaw National Forest. According to this paper, both species richness and abundance of cavity-nesting birds were positively correlated with snag density. Although cavity-nesting birds preferred large snags greater than 6.4 m tall and 102 cm DBH and generally avoided snags less than 28 cm DBH, some use of snags in all size classes was detected. Snags in an intermediate stage of decay were preferred over snags in early or late stages of decay. Each species of cavity nesting bird exhibited somewhat different preferences for size and decay state of snag. To optimize abundance and diversity of cavity-nesting birds, Schreiber and deCalesta recommend that managers should provide at least 14 snags per hectare greater than 28 cm DBH and 6.4 m tall. They recommend that the majority of snags retained be in intermediate stages of decay.

JPH

AN ECOSYSTEM PERSPECTIVE OF RIPARIAN ZONES by S.V. Gregory, F.J. Swanson, W.A. McKee, and K.W. Cummins. 1991. BioScience 41(8):540-551. The authors present a conceptual discussion of an ecosystem perspective for riparian areas. They describe the geomorphic and fluvial processes that create riparian areas and discuss the linkages between aquatic and terrestrial ecosystems in these areas. An ecosystem perspective of riparian areas is presented as an alternative to most riparian classification systems that rely

on the presence or absence of certain selected soil characteristics or vegetation.

The preamble to the discussion of an ecosystem perspective for riparian areas presents a hierarchical structure of valley landforms based on concepts of fluvial geomorphology. The nested geomorphic structures are arranged on both a spatial and a temporal scale that represent the feature size and stability, respectively. The hierarchical structure starts with individual particles at the smallest size and shortest stability over time and progresses through channel subunits, channel units, stream reaches, stream sections, and finally stream networks at the greatest space scale and time scale.

The hierarchical structure of geomorphic surfaces is followed by a discussion of riparian vegetation. Riparian vegetation is characterized by high structural and compositional diversity. The high diversity of riparian vegetation results from a high diversity of microsites within riparian areas; this diversity of microsites results from a dynamic history of flooding in these areas. This high variablility in fluvial processes leaves a range of soil types from perennially wet to well-drained, and the disturbance regime leaves a mosaic of vegetation successional states. The discussion of riparian interactions between forests and streams includes consideration of solar radiation, dissolved nutrient inputs, particulate terrestrial inputs, retention, primary producers, processing of organic matter, aquatic invertebrates, and aquatic vertebrates.

The ecosystem perspective of riparian areas presented by the authors is intended to be applicable to a wide range of land-water interfaces and geographic regions. However, the examples in the paper draw heavily from forested environments in the Pacific Northwest. The paper is a review article and, therefore, is highly descriptive. What the paper lacks in depth is made up for by the 72 references cited. The references leave interested readers with ample opportunity to pursue topics of concern to them.

A reprint of the article is available from the lead author at the Department of Fisheries and Wildlife, Oregon State University, Corvallis, OR 97331.

AES

WATER QUALITY AND OUR FORESTS: WESTERN OREGON RESEARCH by Paul Adams. OSU Agricultural Communications, VTP014. Forest managers are being asked to pay more attention to how their actions in watersheds affect both water quality and supply, as more attention is focused on fish and wildlife, water quality for domestic use, and supplies for irrigation and hydroelectric power generation. A new videotape available from the Oregon State University Extension Service highlights historical and current research about the relationship of water quality and forest management practices. "Water Quality and Our Forests" is intended to update foresters and others about research developments and how forest practices can affect water quality. The 11-minute videotape also can be used as an introduction for discussion groups. Western Oregon examples are used in the overview of water quality issues and research in this tape which was first produced for a national teleconference by Adams and Steve Dodrill, OSU electronic media specialist.

Copies of "Water Quality and Our Forests: Western Oregon Research," VTP 014, are available for $25 each from Publications Orders, Agricultural Communications, OSU, Administrative Services A422, Corvallis, OR 97331-2119.

Leonard Calvert,
OSU Agricultural Communications Department

BIOLOGY OF BATS IN DOUGLAS-FIR FORESTS by R. E. Christy and S. D. West. 1993. USDA Forest Service General Technical Report PNW-GTR-308. 28 p. This publication is one of series of publications summarizing the life history and habitat relationships of species showing strong associations with old-growth forests in the Pacific Northwest. The report provides a good general review of the natural history of 12 species of bats that occur in Douglas-fir forests. Nine of these species are known to roost in tree cavities, bark crevices, or foliage, and several are closely associated with old-growth forests. The publication provides summaries of what is known of the reproduction and survival, food habits, hibernation, movements, roosts, and hibernacula of these species. The paper concludes by summarizing current research on bats in old-growth Douglas-fir forests, other studies on bats in the Northwest, and remaining research needs. The lack of information concerning much of the basic natural history of several bat species is noted. The authors emphasize that the gaps in our knowledge are especially profound with respect to the influence of habitat alteration on bat populations. According to the report, "Responses of bat populations to various forest management practices (for example, riparian buffer strips, clearcutting) and habitat variables (for example, forest fragmentation)... are virtually unknown." The paper includes a bibliography of over 100 references. This paper provides the reader with an excellent introduction to what is known and the considerable gaps in our knowledge of the biology of bats in Douglas-fir forests of the Pacific Northwest.

The report is available from the Pacific Northwest Research Station, 333 S. W. First Avenue, P. O. Box 3890, Portland, OR 97208-3890, (503) 326-7128.

JPH

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